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JANUARY, 1938

Editorial

BASIC KNOWLEDGE

IN research into the problems of disease a knowledge of the normal state is essential before any useful progress can be made or, indeed, expected.

Veterinary workers have for long been painfully aware of this fact. Much information concerning the animal mechanism has been gradually acquired, but it must be acknowledged that the unchartered seas are still wide and numerous.

Our colleagues who work in human medicine have their difficulties and they, too, are conscious of the great want of what might be called basic knowledge. The present renaissance of anatomy might be quoted in support of this contention. The medical man's difficulties are as naught when compared with those of the veterinarian. In veterinary science the great variety of animals encountered, each species differing fundamentally, anatomically, functionally, and as regards environment, adds to the difficulties to be encountered in acquiring and recording this basic knowledge.

Many have been the disappointments of veterinarian men, attracted to a particular line of research when as a preliminary to that work they have attempted to acquire a knowledge of the normal state. Owing to the literature being sterile it has often been necessary that they sit down and spend much time acquiring this knowledge. Time, money and the worker's enthusiasm have often been

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wasted in their efforts. It may be that there are some who, while acknowledging the necessity of such information, would say that this type of work has no attractions.

Nothing could be further from the truth, for it might be compared to astronomy in its scope and interest.

Others may say that the research mind is not suitable or required for such humdrum work. In reply we would deny in the strongest terms such a contention and say, that the intelligent research worker could find as much material to occupy and develop his brain in the search for what we are pleased to call basic facts, as he does in his efforts to elucidate the problems of disease.

The man who attempts to solve the problems of disease without a sound understanding of the normal might be compared to those deluded optimists who enter the complex and variegated field of Bio-chemistry, possessing very little, if any, basic knowledge of Chemistry.

With these views in mind we welcome such a paper as that we are privileged to publish in this issue, on " A Study of the Blood of the Pig."

It is also our intention to publish in the near future an article dealing with the " Intestinal Flora of the Sheep."

We consider it would be good policy and in the best interests of our science if our research and other institutes were to encourage their younger men to make a mass attack on this type of work. As a training ground for the young and active brain, its value might be likened to the study of Euclid in the subject of mathematics, and its beneficent influence on the research into the diseases of the domestic animals would be immeasurable.

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General Articles

A STUDY OF THE BLOOD OF PIGS.

By A. C. FRASER, Ph.D., B.Sc.

A. INTRODUCTION.

THE study of the blood elements of pigs was first suggested by the observation of cases of anæmia in suckling pigs, in which an extraordinary blood picture was presented, when it was found that there did not exist any standard for the appearance, numbers and proportions of the various cells of the blood of pigs to which these findings could be contrasted. This work has been carried out on the same lines as those followed by the author in his study of the blood of cattle and sheep (8), and includes a description of the morphology of the red and white corpuscles as they appear in dried smears and with supra-vital stain. The technique employed was nearly identical with that previously used and the short description of it has been repeated in this paper for the sake of completeness.

Bibliography.

There are a number of publications which have been found useful for the comparison of the numerical findings. *Burnett's* monograph (2) " The Clinical Pathology of the Blood of Domesticated Animals," published in 1917, contained references to the work of eleven authors but the field was very incompletely covered. In 1926, *H. Magnus and Ibrahim Saim* (13) published a detailed numerical report on the blood of thirty pigs between three and ten months old. In 1928, *Doyle, Matthews and Whiting* (7) reported on a comparative investigation of normal and anæmic young pigs; *J. Rudolf* (17) surveyed the German literature for normal blood counts, covering some of the same ground as Burnett and gave a long list of his own findings in various pathological conditions; and in the same year *G. Kohanawa* (11) published his detailed investigation of the blood of twelve adult pigs. His references with one exception are included by Burnett or Rudolf. The anæmia of suckling pigs was described by *McGowan* (12) in 1924 and by *Doyle* (6) and *Hamilton* and others (9) in 1931 and by *Beckett* (1) in 1934.

For methods of technique and for information on histology as well as theoretical deductions, the following books have been drawn upon. *Naegeli's* " Blutkrankheiten und Blutdiagnostik," *Pappenheim's* " Morphologische Hæmatologie and Hæmatologische Bestimmungstafeln," *Jolly's* " Traité Technique d'Hematologie," *Arneth's* Die neutrophilen weissen Blutkorperchen bei Infectionskrankheiten," *Cooke* and *Ponder's* " The Polynuclear Count," Gradwohl's translation of *Schilling's* " Das Blutbild und seine Klinische Verwertung " and *Piney's* " ecent Advances in Hæmatology " and his " Diseases

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of the Blood." "Affections du sang et des organs hæmatopoietiques," in the "Nouveau Traite de Medicine" series; the sections on The Blood in "Nelson's Medicine," and notes of the "Cours de Microbilogie" of the Pasteur Institute, 1930, were also found of value.

B. TECHNIQUE.

Technique.

All the samples of blood were taken from the marginal vein of the ear. The ear was rubbed clean with cotton wool and then wiped with alcohol, the rubbing being continued until the vein was clearly dilated. The vein was then pricked with a Francke spring lancet and one or two cubic centimetres of blood collected from which the preparations were made. The first few drops were always rejected to avoid any local effects of the manipulation and contamination with any tissue particles loosened by the needle.

Counting the Corpuscles.

For the enumeration of the red blood corpuscles the blood was diluted two hundred times in Potain pipettes (1–101), twelve pipettes being selected which gave almost identical counts with a single sample of blood. Where more than one sample of blood was taken from an animal, the same pipette was always used. The diluting fluid which proved most suitable for the blood of all the domestic animals is physiological saline, to every hundred cubic centimetres of which one cubic centimetre of formalin is added. A Burker (Hawksley) hæmocytometer was used for the actual counting, and fifty squares, each side of a square being a four-hundredth of a millimetre, were examined. These were composed of two groups of twelve and two of thirteen squares, one group in each quarter of the ruled area. This involved the counting of 300 to 600 cells.

The white blood corpuscles were counted in Potain pipettes (1–11), four per cent. acetic acid being used as the diluting fluid. The white corpuscles covering one square millimetre in each quarter of the ruled area were counted, unless very scarce, in which case the whole ruled area was usually surveyed. The Burker hæmacytometer is provided with two ruled plateaux separated by a ditch, enabling the red and white cell preparations to be mounted at the same time.

The twelve platelet counts were made on samples taken from the ear vein through a paraffin-lined needle into a watch glass containing a few drops of *Cramer and Bannerman's* (4) solution.

Sodium citrate	0.2 gms.
Sodium chloride	0.2 gms.
Brilliant Cresyl blue 1 per cent. solution	1 cc.
Formalin	2 cc.
Distilled water	100 cc.

A drop of blood from the needle was gently mixed with the solution in a paraffined watch glass with a paraffined glass rod and a small drop transferred to a cover-glass which was then inverted on a slide and luted with vaseline.

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The numbers of platelets occurring in a count of a thousand red blood corpuscles were recorded in ten groups of a hundred corpuscles and the number of platelets per cubic millimetre of blood calculated from a separate red blood cell count.

Supra-vital staining.

For the study of the living cells brilliant cresyl blue, neutral red and a neutral red and Janus green mixture were used as described by *Sabin* (18). Brilliant cresyl blue preparations were made as a routine measure for the demonstration of reticulocytes. The staining solutions were allowed to dry in a thin smear on the slides which were prepared in a quantity and stored dry. In use a small drop of fresh undiluted blood was transferred from the watch glass to a coverslip which was then gently lowered on to the slide, the edges of the slip being luted with vaseline. Corpuscles containing the reticular substance stain in a few moments. The number of reticulocytes is recorded as a percentage of the red blood corpuscles. Permanent preparations of reticulocytes prepared by the methods described by *Cunningham* (5) were also made. The slips are allowed to remain on the slides for a few minutes, then drawn off and counter stained, after fixation, with a Romanowski stain. These preparations were found to be unsatisfactory for statistical purposes, as, even when fixed in formalin and alcohol and washed very gently, reduced counts were recorded when compared with counts made on wet preparations. For the reticulocyte counts a warm stage is not necessary, but to observe the living cells in the neutral red and Janus green preparations the slides were kept at 37°C. by means of a warm stage.

C. THE BLOOD OF NORMAL PIGS.

The result of the examinations of the blood of healthy pigs is divided into two parts, (*a*) The morphology of the blood elements, and (*b*) The numbers of the blood elements. For purposes of comparison and contrast the animals have been divided into four groups according to age; Group 1, young sucklings from birth to three days old; Group II, sucklings, from one week to one month old; Group III, feeding pigs, from two to seven months; and Group IV, adult pigs, from one to two years.

(A). The Morphology of the Blood Elements.

The Red Corpuscles.

(Neutral red and Janus green.)

In these preparations the red blood corpuscles appeared pale green to pale yellow. The nuclei of the normoblasts take a dark red-brown stain. A number of the corpuscles contained mitachondria, these appearing as three or four short bacilli like green rods. These were non-motile.

The White Corpuscles.

(Neutral red and Janus green.)

The various white corpuscles can be differentiated by the general form of their nuclei and the presence or absence of granules.

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The Lymphocytes.

The cytoplasm of the lymphocytes remains clear. In none of them did any granules appear which might correspond to the large or small granules seen (very rarely) in Giemsa-stained films. No mitachondria were seen. Both large and small lymphocytes were observed to move slowly with little alteration in shape.

The Monocytes

The monocytes show a cytoplasm of a finely granular appearance. There are a few brilliant granules, of varying size, gathered together in the hilus of the nucleus. Movement is slow and appears to be by pseudopodia, a large bulk of the cell taking part in the formation of the "foot." A small percentage of the monocytes showed vacuole-like yellow bodies.

The neutrophile Leucocytes.

The neutrophile leucocytes present a pale green nucleus with an almost clear cytoplasm filled with a haze of small reddish dots. The cells progress by pseudopodia and their movement is rapid when compared to that of the lymphocytes and monocytes. The nucleus is not constant in shape during these movements.

The Eosinophile Leucocytes.

The granules of these cells almost totally obscure the cytoplasm and nucleus. The cytoplasm can be observed at the advancing border of the cell when it is in motion which is extremely deliberate. The nucleus remains unstained. The granules take a yellowish stain with neutral red.

The Basophile Leucocytes.

These are comparatively rare in the pig and appear to be of two types. The cytoplasm is entirely obscured by granules in one type; in the other there is an amount of clear cytoplasm in which a few small granules are scattered. In both types the granules take a reddish brown stain.

The Red Corpuscles.

(Cresyl blue.)

Reticulocytes occurred in all the pigs examined (up to two years). The recticular substance resembled that seen in the corpuscles of the blood of humans and of other animals, staining as strings and clumps of a granular dark blue substance most frequently in a circular mass or a corona.

The appearance of the red and white corpuscles in fixed preparations.

The films for studying the size, shape and detailed appearance of the various corpuscles, and for making the differential counts of the white cells were prepared by Ehrlich's method (14) allowing a small drop of blood to spread evenly between two slips which are then drawn apart. The coverslips were prepared clean and

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free from grease by subjecting them to the fumes produced by adding nitric acid to ethyl alcohol. They were then washed in neutral distilled water until the washings were no longer acid to litmus and finally stored in absolute alcohol from which they were taken and flamed as required. The films were stained with Leishman stain, applied and then diluted with distilled water at p.H.7.

The cell measurements were made by means of a Leitz micrometer scale inserted in the eye-piece of the microscope.

The red blood corpuscles take up the eosin from the compound stains, giving a slightly orange red colour. No finer structures can be made out, the staining being evenly diffused through the cell except that the centre appears paler than the periphery owing to the biconcave formation of the corpuscle. In pigs of all ages there appear some polychromatic cells. These correspond closely in numbers to the reticulocytes seen in the fresh preparations. In young pigs they are present in large numbers. These young cells have a ready affinity for the blue stain, unlike the corresponding cells of sheep and cattle, in which animals the reticulocyte count always considerably exceeds the count of polychromatophilic cells. Punctate basophilia does not occur in pigs, even in the hæmatopoietic tissues before birth.

The average size of the red blood corpuscles is 5.4m., the limits of size found in normal pigs being 2.8m. to 10m. This variation is the greatest of all domesticated animals and the number of cells differing widely from the mean is also great. The common range is from 4.6m. to 6.2m., there being then a gap on either side until the groups 2.8m. to 3.4m. and 8.6m. to 10m. are reached. There are considerably more of the very large than the very small cells. In sheep, under certain pathological conditions, a crop of very large cells occurs which have a definite basophile cytoplasm and tend to occur in clumps, but these macrocytes in the pig have no special cytoplasmic staining affinities. Both they and the microcytes appear to be normal in every way.

The lymphocytes vary in size from 5m. to 12m. with an average size of 8.8m. Small lymphocytes range from 5m. to 7m., while the large lymphocytes usually range from 8m. to 10m. There is a complete range of intermediate sizes making it impossible to divide up the two groups distinctly. Absolute differentiation by staining is also impossible, as although there are clearly marked differences in the cells at the extreme limits of size, all transitional grades occur from the compact nucleus with a tiny blob or thin crescent of cytoplasm at one side to the large cell with a more diffusely staining nucleus surrounded by a clear band of cytoplasm. In the small forms the nucleus stains a very intense red-brown and basi and oxy-chromatin are not distinguishable. In the larger forms heavily staining nuclear masses are separated by pale narrow bands, but the structure is obscure. The nucleus, almost always round in the small forms, is round, oval or kidney-shaped in the lymphocyte. The bi-lobed form has not been observed in the pig. The cytoplasm stains with Giemsa a clear blue

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or grey-blue. In the larger cells there is seen a paler zone surrounding the nucleus. There is quite clear distinction in this species between the cytoplasmic consistency in the lymphocytes and that in the monocytes. The latter is quite granular, and the difficulties of differentiation which occur in some animals are thereby avoided in the pig.

Azurophile granules as inclusion bodies in the cytoplasm of the lymphocytes are rare. Of the large and small granules occurring in man and some animals, only the small granules have been observed in the pig and they occur in a very small proportion of the cells and then only singly or in pairs. Some of the large lymphocytes showed one or more vacuole-like bodies.

The monocytes present a range in size from 8m. to 17m. Cells of less diameter than 13m. are not common. There is less difficulty in distinguishing the monocytes from lymphocytes than in most species of animal and transitional cells do not occur in sufficient number to have a significant effect on the count. The cytoplasm shows as a granular substance staining pearly grey or dull grey and rarely contains any granules or other inclusion bodies. A few cells show vacuole-like inclusions or "Kurloff bodies," taking a yellowish stain and resembling those seen in the lymphocytes. The nucleus shows the open network of basi-chromatin with many thickenings typical of the monocyte and is usually oval in shape. Few round nuclei occur; these chiefly in the smaller cells. A very few nuclei with a third lobe occur in the larger cells.

The neutrophile leucocytes vary from 6.2m. to 12.2m. with an average size of 9.5m. The protoplasm stains a clear primrose yellow and contains numerous granules staining red or brown which are much smaller than those occurring in other species. The nucleus closely resembles that of the corresponding human cell both in its staining qualities and its segmentation. Each lobule of the nucleus appears to consist of a thick twisted band of basi-chromatin with a core of oxychromatin. In the younger forms the arrangement is simple and the oxychromatin predominates, but as the nuclei increase in lobulation, so the convolutions of basi-chromatin appear to become more compact and their course more difficult to follow, and the amount of oxychromatic material visible is greatly reduced. Like the neutrophiles of human blood the nuclei of these cells break into distinct lobes connected only by very thin threads of chromatin. This makes the Arneth Index as modified by *Cooke* (3) comparatively easy to determine.

The Arneth (Cooke) Index for healthy pigs was found to be:

	Class I	*Class II*	*Class III*	*Class IV*	*Class V*
Adult pigs	11%	45%	31%	10%	3%
Young pigs	35%	46%	12%	6%	1%
Suckling pigs ...	23%	47%	19%	9%	2%

Adult human standard for comparison:

Class I	*Class II*	*Class III*	*Class IV*	*Class V*
12%	25%	44%	15%	4%

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The *Schilling* Hæmogram (16) is a more delicate index of alteration in the leucocyte type present in the blood in pathological conditions. The hæmogram for healthy pigs is:

	Myelocytes	*Young forms*	*Band forms*	*Mature cells*
Adult pigs		0.4%	8.6%	91%
Young pigs		1.2%	11%	87.8%
Suckling pigs		0.8%	11%	88.2%

The Eosinophile Leucocyte varies from 10m. to 15m. in diameter; usually about 11m. They are thus only slightly larger than the average neutrophile cell; in smears they stand out so boldly and their granules are so large and clear cut that they appear to be much larger than the faintly staining "Polymorph." The granules stain a pinky blue colour. The nucleus is usually bar-shaped and indented or S-shaped, and less commonly divided into two segments. Three lobules are rare, and more complicated nuclei were not observed.

The Basophile Leucocytes are the largest of all the white corpuscles in the pig, ranging from 12m. to 16m. in diameter. There appear to be two types of this cell; one common type completely distended by large darkly staining granules obscuring both nucleus and cytoplasm, and a much rarer cell containing a few small basophilic granules with a round or oval darkly staining nucleus and a quantity of basophile protoplasm.

Only one **plasma cell** was observed in all the slides of normal blood examined (Table III, Fig. 8).

The Platelets vary in size from 1m. to 5m. with a usual size of 2m. They do not differ in size or appearance from those of other species, consisting of a clear plasma, apparently limited by a membrane and containing numerous granules which take a dark bluish stain. The granules vary in number from one or two to about forty. The plasma stains a light yellow colour. When the platelets agglomerate they appear to lose their limiting membrane and are seen as a mass of purplish blue granules. The cytoplasm cannot be distinguished in these masses and is presumably lost. Individually the platelets are round or oval with or without tiny pseudopodia. In supra-vitally stained preparations the plasma does not take any colour, the granules showing as reddish brown dots. With cresyl blue the cytoplasm stains pale blue and the granules dark blue.

SUMMARY

C. THE BLOOD OF NORMAL PIGS.

(A) The Morphology of the Blood Elements.

The appearance of the various elements of the blood are described and their measurements are found to be as follows: Red corpuscles 2.8m.—10m., lymphocytes 5m.—12m., monocytes 8m.—17m., neutrophile leucocytes 6m.—12m., eosinophile leucocytes 10m.—15m., basophile leucocytes 12m.—15m., and platelets 1m.—5m.

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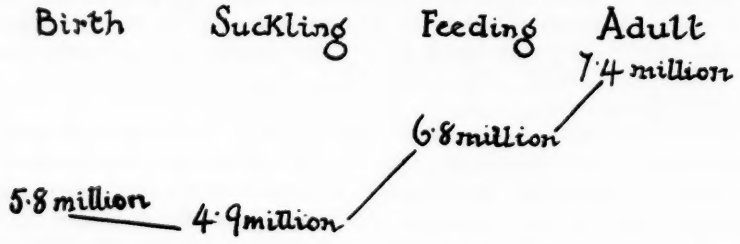
The red corpuscles vary in size more than those of any of the domesticated animals. The remainder of the types do not differ in size or staining reactions to any remarkable extent from those of other animals.

C. THE BLOOD OF NORMAL PIGS

(B) The Numbers of the Cells.

The numbers of the various types of cells are set out in Tables I to IV. The age of the pigs has been recorded in all cases. The tables cover the following groups of animals: **young sucklings** from birth to three days old (Table I); **sucklings** from one week to one month old (Table II); **feeding pigs** from two to seven months old (Table III); and **adult pigs** from one to two years old (Table IV). Table V shows the effects of parturition on the blood of a sow. The numbers of red blood corpuscles (R.b.cs.) are expressed to the nearest thousand per cubic millimetre of blood. The total white blood corpuscles (W.b.cs.) are expressed to the nearest thousand per cubic millimetre. The numbers of lymphocytes (Ly.), monocytes (Mo.), and neutrophile (Ne.), eosinophile (Eo.), and basophile (Ba.), leucocytes and plasma cells occurring are expressed as a percentage of the total number of white blood corpuscles. The figures given in the columns for nomoblasts (N.) and Jolly bodies (J.) indicate the number of these types of red corpuscles observed in the counting of a thousand white corpuscles, equivalent, roughly, to the observation of half a million red corpuscles. The reticulocytes are recorded as an actual percentage of the red corpuscles.



The red blood corpuscles.

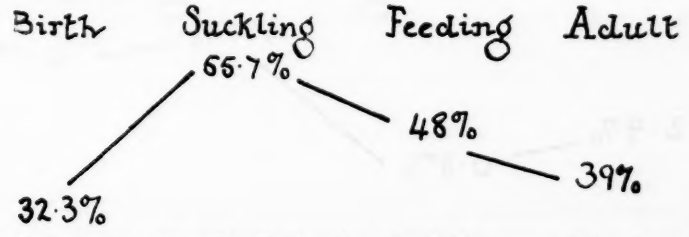
The number of red corpuscles per cubic millimetre in the blood of pigs varies widely at all ages. The average of all the groups examined lies just over six million with extremes of 3,136,000 and 9,046,000. Age plays a great part in determining the gross differences. During the first few days of life the counts vary from 4.3 to 7.1 million with an average of 5.8 million. The average for the group from one week to one month old falls by nearly a million to 4.9 million with extremes of 3.1 and 7.8 million. Between two and seven months the count has increased to an average of 6.8 million (varying from 5 to 8.2 million) while adult pigs give an average of half a million more; 7.4 million with extremes of 5.4 and

9 million. The variations inside the groups are wider than those found in other species and may be partially accounted for by the multiplicity of methods of pig feeding and management. Kohanawa, however, notes that in twelve adult pigs examined at a slaughter house the red cell count (6 to 7.3 million) showed the smallest variation of any of the species he examined. The most striking feature of the red cell count is the low figure recorded for many of the suckling pigs. In most species of animal there is a slight drop in the red cell count from birth for a few hours or days which is a fall from a high birth figure to a figure approximating that of the adult, but in no other animal is there recorded so persistent and so consistent a fall at this or any other period of life. *Doyle, Matthews* and *Whiting* (7) record a similar state of affairs in America, their figures for healthy pigs being 5.2 million at two days old, 3.8 million at sixteen days, six million at forty-seven days and 6.8 million at ninety days, and they suggest that a decline in red blood corpuscles is normal in young pigs. It certainly appears to be a constant phenomenon and must be allowed for in any observations on young pigs but it may rather be an indication of an abnormality brought on by domestication of pigs and by modern pig-raising methods than an actual normal developmental trait in the pig. The decision as to the guilt or innocence of domestication could only be satisfactorily cleared up by examinations of suckling wild pigs, a thing outside the range of feasibility, but the effect of varying the methods of pig management and diet can be investigated and it is seen later in this paper that the red blood cell counts of young pigs can be affected in this way.

The white blood corpuscles.

The number of white blood corpuscles per cubic millimetre averages 17,000 over all the groups with extremes of 5,000 and 31,000. This is a wider range than in any other species observed except the rat. (11A.) The average in the very young pigs is 20,000 ranging from 9,000 to 28,000, in suckling pigs from 5,000 to 21,000 averaging 10,000, in young pigs from 10,000 to 31,000 averaging 21,000 and in adult pigs from 9,000 to 28,000 averaging 15,000.

The lymphocytes.



The lymphocytes over the whole series of animals average 44 per cent. with extremes of 9.2% to 74%. The average percentage is lowest in the very young pigs (32,3%) rising to 55.7% in the sucklings and falling to 48% and 39% respectively for the feeding pigs and the adults.

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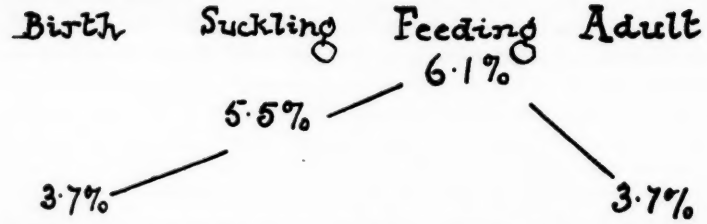
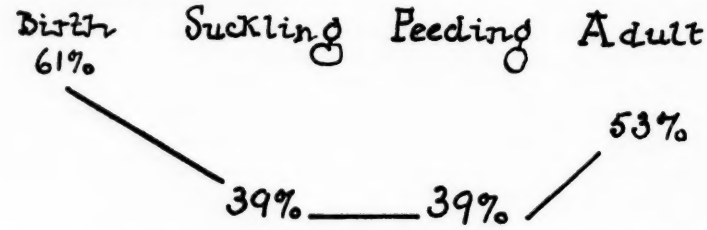
The monocytes.



The monocytes of all the groups of pigs average 5% with extremes of 1.6% and 10%. The average percentage is 3.7% for both the very young pigs and the adults and is 5.5% and 6.1% respectively for the sucklings and growing pigs.

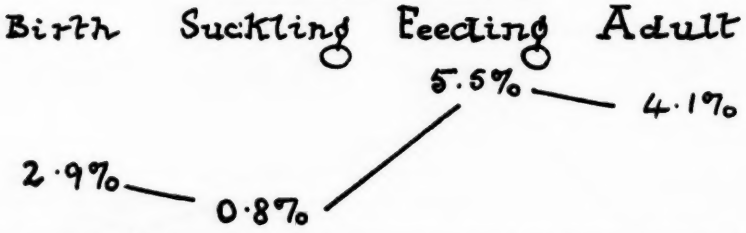
The neutrophile leucocytes.



The average for the neutrophile leucocytes for the whole series is 48% with limits of 22.8% and 87.6%.

There is a fall from 61% in the very young pigs to 39% in sucklings and growing pigs with a rise to 53% in the adult pigs.

The Eosinophile Leucocytes.



The eosinophile leucocytes of all the groups average 4.4% ranging from nothing to 11.2%. They are most variable in the very young pigs, this group covering the full range from nothing to 11.2% and averaging 2.9%. The sucklings range from nothing to 4.2% with an average of 0.8%. The eosinophiles are constantly present in the two older groups averaging 5.5% and 4.1% in the feeding and adult pigs respectively.

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The Basophile Leucocytes.

Basophile leucocytes are not constantly present in any of the groups. They average .7% throughout and reach 1.6% in the very young and 1.4% in the adult groups. The averages for the four groups respectively are 0.3%, 0.1%, 0.5% and 0.4%.

Plasma Cells.

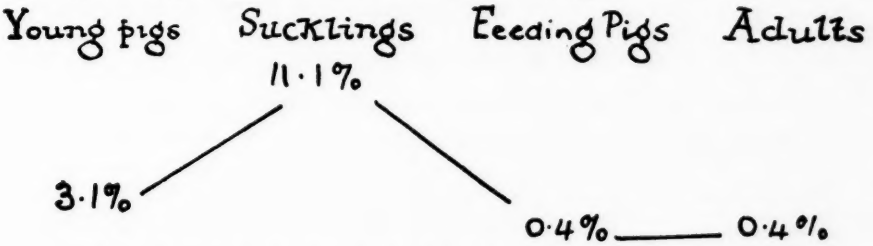
Only one cell of this type was observed: in a seven months old pig.

The Platelets.

In six counts of suckling and six counts of adult pigs the platelets averaged 350,000 per cubic millimetre, ranging from 120,000 to 720,000. *Pertev* (15) gives 400,000 as the figure for pigs in his thesis on blood platelets.

The Reticulocytes.

The reticulocytes vary over the whole series from 0.1% to 36% of the total number of red blood corpuscles. In the very young pigs they range from 1.8% to 5%, in the sucklings from 1.8% to 36%, in the growing pigs from 0.1% to 1.2% and in the adults from 0.1% to 0.8%.



Of the farm animals the pig is the only one in which reticulocytes are constantly present in the blood stream. In horses, cattle and sheep, the presence of reticulocytes is an indication of excessive stimulation of hæmatopoietic tissues which are unable to meet the demand of the organism for red blood corpuscles without including these immature (10) forms in the supply. Their presence in the circulating blood in these animals is therefore a useful indication of an abnormal state. In the pig, this indicator is always present and the percentage of this type of corpuscle can be rapidly ascertained by the simple technique already described. Their number is an indication of the activity of the blood-forming organs. The high counts recorded in the suckling pigs together with the low counts for red corpuscles indicate that though there is a state of anæmia, the animal is actively countering the condition by the rapid production of corpuscles. A low red cell count with a low reticulocyte percentage would suggest an aplastic condition of the blood-forming tissues leading to an unfavourable prognosis in the case. In the blood counts of suckling pigs in Table II it will be seen that all pigs with a red corpuscle count under four million show a

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reticulocyte percentage of eight or over, while those with a red cell count of over six million have reticulocyte percentage of less than three and a half. A favourable prognosis in these cases would have been borne out by a clinical examination.

The effect of parturition on the blood of a sow. (Table V.)

Four samples of blood were taken from a sow at the following times in relation to the completion of farrowing: five days before, three days before, eight hours after and twenty-four hours after. The findings are set out in Table V.

There is no deviation from the figures laid down for adult pigs except in the count taken eight hours after farrowing, in which the figure for white blood corpuscles was found to be 45,000 per cubic millimetre. This is accounted for by an increase of neutrophile leucocytes from between 40% and 50% to 93.4% accompanied by an actual as well as a percentage decrease in the number of lymphocytes. The monocytes, eosinophiles and red corpuscles remain about the same in actual numbers per cubic millimetre. The basophile cells disappear completely. There is a slight increase in reticulocytes from 0.6% and 0.4% to 0.9%. Twenty-four hours after farrowing all the figures are back to normal again.

SUMMARY

C. THE BLOOD OF NORMAL PIGS.

(B) THE NUMBERS OF THE BLOOD ELEMENTS.

The findings in round figures are as follows:

	R.B.c.s.	Retics.	W.B.c.s.	Ly.	Mo.	Ne.	Eo.	Ba.
Young Sucklings	... 4–7	2–5%	10–30	10–50	2–5	40–90	0–10	0–2
Sucklings ...	... 3–7	2–40%	5–20	30–70	2–10	20–60	0–5	0–1
Feeding pigs ...	... 5–8	0.1–1%	10–30	40–60	5–10	30–50	3–10	0–1
Adult pigs ...	... 5–0	0.1–1½%	10–30	20–50	2–10	30–70	2–5	0–1
	Millions		Thousands			Percentages		

The findings of various authors for normal pigs are given for comparison in Table IX. It will be noted that with one or two slight exceptions these figures are covered by the range given in the Summary.

D. THE BLOOD OF PIGS SUFFERING FROM ANÆMIA.

It has been known for some years that practically all young pigs suffer a diminution in the number of red blood corpuscles per cubic millimetre of circulating blood during the first few weeks of life. *Doyle and Others* (7) reported in 1928 on an examination of the blood of about a hundred young pigs, and suggested that a decline in the number of red blood corpuscles was normal in pigs at this stage of their existence. It has been stated that the cleaner pigs are kept the more anæmia occurs (19). The condition appears to be a constant accompaniment of modern methods of pig rearing. To ascertain the effect of this anæmia on the development of the young pig, two litters were weighed at weekly intervals from birth to six weeks of age. These pigs were confined to the stye until the second week. The weights are given for the two litters of

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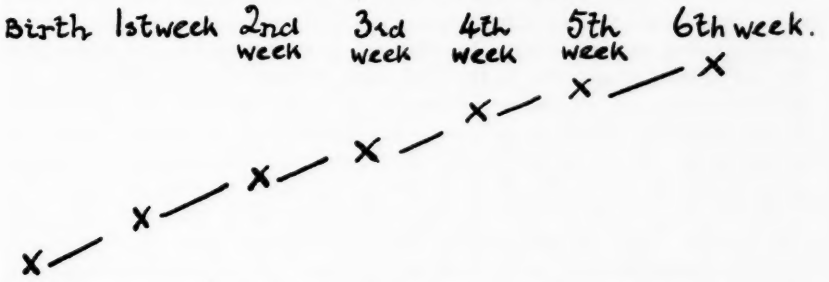
nine and eight pigs in Table VI. From these it can be calculated that during the first week the average weight of these seventeen pigs increased by 37%. The average increases for the second and succeeding weeks was 11%, 18%, 28%, 23%, and 19%. This may be represented graphically thus:



These pigs were clinically in perfect health throughout the period of the records. In cases of anæmia which can be detected clinically the effects of the set back occurring at this stage of development are far more severe and frequently cause the death of part or all of the affected litter with symptoms and post mortem appearances that have been frequently described (1.6.9.12.). The disease is distinct from cotton seed poisoning (7).

No success has followed experiments in which an attempt has been made to check this anæmia by treating the sow (1). Rapid cures have been obtained in early cases by dosing individual young pigs with salts of iron, or iron and copper (7.9), or by turning out to grass or by placing sods or turf in the sty (6). Giving greenstuff alone is not satisfactory (6).

Table VII gives (*a*) the blood counts of a gilt and her five sucklings at three weeks of age affected with anæmia. Two of the sucklings died. The other three recovered without any treatment other than by turning out to grass. Counts on the blood were repeated at thirty and sixty days.

The points of note apart from the red cell count which increases as the animals recover is the high eosinophile count and the high percentage of reticulocytes each of which declines as the animals proceed towards recovery. The average counts of the three sucklings which recovered are as follows:

At three weeks (apparently very anæmic) red cells 4,331,000 per c.mm., reticulocytes 24%, eosinophile 24.7%. At thirty days (apparently recovering) red cells 6,080,000 per c.mm., reticulocytes 11%, eosinophile 20%. At sixty days (apparently recovered) red cells 6,667,000 per c.mm., reticulocytes 3%, eosinophile 9%. These last figures fall within the normal findings for adult pigs except for a slightly higher count of reticulocytes. The only way to avoid this disease would seem to be by farrowing the sows in the field or by giving the

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young pigs from birth access to soil or turf from which they can obtain the elements necessary for proper hæmatopoiesis. In any but advanced cases a cure can be effected by turning out the young pigs or otherwise bringing them into contact with soil. The blood picture in a case of anæmia in suckling pigs is notable for the varied appearances of the red corpuscles. In the majority of cases the corpuscles are not oligochromæmic, but anisocytosis is marked, megalocytes predominating in early cases. In advanced cases microcytes and schizocytes become more frequent and in the final stage of fatal cases poikilocytosis and chlorosis occur, and corpuscles of normal colour, size and shape are exceptional. Polychromasia is marked in early cases but decreases as the anæmia progresses in fatal cases. This is in parallel with the occurrence of reticulocytes. Prognosis is good even in severe cases if the percentage of these two types is high. The numbers of normoblasts and corpuscles containing Jolly bodies do not alter significantly. They are present in the blood of all young pigs. Cabot rings and punctate basophilia were not observed in any cases. The white blood corpuscles remain normal in appearance throughout and there is no influx of young lymphocytes or young leucocytes such as occurs in many anæmias. In numbers, the red corpuscles may decrease to a figure between one million and two million per cubic millimetre before death occurs: the white corpuscles vary considerably in total numbers, but not greatly outside the limits found in healthy pigs. The notable variation of the types of white cells is the marked percentage and actual increase of eosinophile cells.

The disease may be classified as a simple aplastic anæmia.

The pigs whose blood showed the above changes were free from worms. Table VIII gives the blood counts of three non-anæmic young pigs in poor condition badly infested with strongyles. The counts fall within the normal figures and there is no eosinophilia.

E. GENERAL SUMMARY AND CONCLUSIONS.

The blood of pigs has been examined at various ages from within a few moments of birth to the adult state. The appearances of the elements in supravitally stained and in fixed specimens have been described and discussed, and the actual numbers in which they presented themselves and the proportions in which they appeared, have been recorded.

The numerical standards obtained for adult pigs are in round figures: red blood corpuscles, 5 to 9 million per cubic millimetre and white corpuscles, 10 to 30 thousand per cubic millimetre, of which lymphocytes form 20%—50%, monocytes, 2%—10%, neutrophile leucocytes, 30%—70%, eosinophileleucocutes, 2%—5%, and basophile leucocytes, 0—1.4%. Platelets average 350,000 per cubic millimetre. The percentage of reticulocytes amongst the red corpuscles is 0.1%—1%. Nomoblasts and Jolly bodies are usually present in small numbers. Young animals show a slightly lower red cell count (4—8 millions) with a higher

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percentage of reticulocytes (2%—5%). The act of farrowing causes, in the sow, a marked but transient increase in the number of neutrophile leucocytes in the circulating blood.

The blood of apparently healthy suckling pigs is strikingly different from that of adult pigs and from that of new-born pigs and it gives many of the indications of an anæmia which is usually transient and comparatively harmless though it undoubtedly results in a slight check in the pig's development. This check in the increase of weight in young pigs is described. The changes in the blood of animals suffering from an extreme condition of this anæmia are described. The chief numerical alteration is that the red corpuscles decrease considerably. There is a fall in the average number of white corpuscles due to a decrease in neutrophile leucocytes. There is a percentage and actual rise in the number of eosinophiles. This does not appear to be related to the presence of internal parasites. The morphological changes affect only the red cells which assume the extraordinary variety of shapes and sizes typical of pernicious anæmia in the human being. The number of reticulocytes is raised, particularly in cases proceeding to recovery. Nomoblasts and Jolly bodies are not increased in numbers. The condition appears to be a simple aplastic anæmia due to lack of contact with the soil resulting in insufficient intake of some of the metallic salts.

The numerical findings for healthy animals have been compared with those reported by other workers in various parts of the world, with close agreement in most cases and it would seem that the numbers and proportions of the various elements are sufficiently constant in health for the figures given above to serve as standards for the blood of pigs.

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TABLE I.

YOUNG SUCKLINGS.

Pigs from Birth to 3 days old.

	Age.	Breed.	Rbcs.	Wbcs.	Ly.	Mo.	Ne.	Eo.	Ba.	per 10,000 Wbcs. Retcs.	N.	J.
1.	At births	L.W.	6,232,000	16,000	19.2	5.0	75.6	—	0.2	3.9%	2	8
2.	,,	,, ...	5,372,000	27,000	28.2	3.8	64.4	3.6	—	4.7%	2	6
3.	,,	L.W. Berks	7,136,000	15,000	30.4	3.4	55.0	11.2	—	3.6%	4	10
4.	,,	,, ...	5,248,000	28,000	9.2	3.0	87.6	0.8	0.4	5.0%	2	4
5.	,,	,, ...	5,824,000	24,000	27.2	1.6	65.4	5.8	—	4.3%	-	6
6.	1 day	Tamworth	5,632,000	9,000	43.0	5.4	50.0	—	1.6	—	2	2
7.	2 days	L.W. ,, ...	6,420,000	14,000	49.4	4.6	45.0	1.0	—	3.4%	4	4
8.	3 days	,, ...	4,362,000	27,000	51.6	2.4	45.4	0.4	0.2	1.8%	6	2
	Average	... ...	5,778,000	20,000	32.3	3.7	61.0	2.9	0.3	3.1%	3	5
	Limits	... ... {	4,362,000	9,000	9.2	1.6	45.0	0	0	1.8%	0	2
			7,136,000	28,000	51.6	5.4	87.6	11.2	1.6	5.0%	6	10

TABLE II.

SUCKLINGS.

Pigs from 1 week to 1 month.

Age.	Breed.	Rbcs.	Wbcs.	Ly.	Mo.	Ne.	Eo.	Ba.	Retics.	N.	J.
6 days	L.W.	3,715,000	8,000	37.2	9.8	50.8	2.2	—	11.0%	-	2
,,	,, ...	3,350,000	8,000	52.6	4.2	43.2	—	—	9.0%	10	2
7 days	,, ...	5,376,000	13,000	44.0	8.0	47.8	0.2	—	8.2%	4	-
,,	,, ...	6,784,000	16,000	53.0	5.4	41.6	—	—	3.1%	4	2
10 days	,, ...	3,488,000	6,000	60.3	10.0	29.2	—	—	12.0%	6	6
,,	,, ...	4,256,000	15,000	74.0	3.2	22.8	—	—	11.0%	-	12
,,	,, ...	4,096,000	7,000	48.8	8.2	42.6	0.2	0.2	14.0%	14	22
,,	,, ...	5,600,000	5,000	54.6	4.6	38.0	2.8	—	6.0%	6	2
,,	,, ...	5,056,000	11,000	53.4	4.8	40.0	1.8	—	—	13	2
,,	,, ...	4,032,000	7,000	55.8	9.2	34.4	0.6	—	—	6	12
12 days	,, ...	3,776,000	9,000	65.0	4.4	30.0	0.6	—	15.0%	8	4
,,	,, ...	3,712,000	7,000	52.4	8.4	38.8	0.4	—	25.0%	10	8
,,	,, ...	3,808,000	14,000	63.0	6.0	31.0	—	—	26.0%	16	10
,,	,, ...	4,256,000	8,000	69.6	4.4	25.2	0.8	—	36.0%	6	2
,,	,, ...	4,320,000	19,000	51.0	7.0	41.4	0.6	—	18.0%	8	2
,,	,, ...	4,596,000	13,000	52.4	6.2	41.2	0.2	—	21.0%	4	-
,,	,, ...	3,904,000	10,000	63.8	3.6	32.4	0.2	—	16.0%	10	8
,,	,, ...	3,136,000	15,000	52.2	2.4	45.4	—	—	14.0%	12	-
14 days	,, ...	6,336,000	12,000	68.6	3.2	27.2	1.0	—	2.4%	2	16
,,	,, ...	6,368,000	11,000	56.2	3.8	40.0	—	—	3.2%	6	-

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15 days	„	...	...	...	...	5,536,000	7,000	57.8	3.0	38.2	1.0	—	9.6%	2	10
„	„	...	...	...	...	5,760,000	21,000	62.2	4.2	29.0	4.2	0.4	9.0%	6	12
„	„	...	...	...	...	3,392,000	8,000	51.0	4.4	42.0	2.6	—	8.3%	6	6
17 days	„	...	...	...	...	5,504,000	5,000	45.0	9.6	44.6	—	0.8	11.0%	2	-
„	„	...	...	...	...	5,696,000	13,000	68.2	6.2	24.0	0.4	1.2	13.0%	4	2
„	„	...	...	...	...	4,960,000	6,000	32.4	5.0	62.0	0.2	0.4	7.0%	-	4
„	„	...	...	...	...	3,776,000	16,000	61.8	3.4	31.8	3.0	—	8.0%	4	2
„	„	...	...	...	...	4,032,000	7,000	59.2	6.4	34.2	—	—	4.2%	2	0
„	„	...	...	...	...	4,288,000	9,000	55.0	4.0	39.8	0.2	0.1	—	-	2
„	„	...	...	...	...	4,192,000	6,000	48.6	6.6	42.6	2.2	—	—	6	2
21 days	„	...	...	...	...	7,360,000	15,000	47.4	6.2	45.0	1.4	—	4.0%	4	4
„	„	...	...	...	...	5,568,000	17,000	47.2	4.4	47.2	0.8	—	3.3%	2	-
1 month	„	...	...	...	...	5,664,000	15,000	62.4	2.6	34.8	—	0.2	2.0%	2	-
„	„	...	...	...	...	5,472,000	14,000	67.6	3.6	28.0	0.6	0.2	1.8%	2	4
Average		...	...	...	...	4,881,000	10,000	55.7	5.5	39.6	0.8	0.1	11.1%	6	5
Limits		...	...	...	{	3,136,000	5,000	32.4	2.4	22.8	0.0	0.0	1.8%	0	0
						7,360,000	21,000	74.0	10.0	62.0	4.2	1.2	36.0%	18	22

TABLE III.

FEEDING PIGS.

Pigs 2—7 months old.

						Rbcs.	Wbcs.	Ly.	Mo.	Ne.	Eo.	Ba.	Retics.	N.	J.
2 months	...	...	...	...	...	6,048,000	26,000	42.0	6.4	47.4	4.0	0.2	0.3%	6	2
						6,848,000	23,000	44.4	5.0	43.4	7.2	—	0.1%	0	6
						6,752,000	31,000	54.8	5.6	33.4	6.2	—	0.6%	2	0
3 months	...	...	...	...	...	7,712,000	12,000	52.0	4.8	39.2	2.6	1.4	0.4%	2	0
						8,192,000	28,000	53.2	8.8	34.0	4.0	—	0.3%	0	0
						6,144,000		42.2	7.4	46.0	4.2	—	1.2%	6	4
7 months	...	...	...	...	...	6,688,000	18,000	57.0	5.4	33.2	4.4	—	0.1%	8	4
						6,400,000	10,000	48.6	6.2	39.8	4.0	1.2	0.4%	4	6
						8,000,000	26,000	52.0	5.2	33.6	8.2	1.0	0.7%	0	0
						4,960,000	20,000	40.4	8.0	40.8	9.6	1.2	0.3%	2	0
						7,328,000	18,000	41.8	4.2	48.0	5.8	0.2	0.5%	2	4
Average		...	...	...	...	6,825,000	21,000	48.0	6.1	39.9	5.5	0.5	0.4%	3	2
Limits		...	...	...	{	4,960,000	10,000	40.4	4.2	33.2	2.6	0	0.1%	0	0
						8,192,000	31,000	57.0	8.8	48.0	9.6	1.4	1.2%	8	6

TABLE IV.
ADULT PIGS
Pigs 1—2 years.

	Rbcs.	Wbcs.	Ly.	Mo.	Ne.	Eo.	Ba.	Retics.	N.	J.
2-year-old Tamworth	7,840,000	17,000	26.4	4.2	65.2	4.2	—	.4%	0	0
2-year-old L. White	8,272,000	21,000	42.2	3.0	52.8	1.8	0.2	0.2%	0	0
2-year-old L. White	7,280,000	14,000	32.8	2.4	60.6	4.2	—	0.3%	0	0
2-year-old cut pig (aver. of 3 counts) ...	8,192,000	9,000	43.4	4.4	46.8	4.2	1.2	0.5%	2	2
2-year-old Berkshire, in pig	9,046,000	28,000	51.4	7.6	35.0	5.4	0.4	0.4%	;	2
2-year-old L. White, in pig	6,752,000	12,000	41.8	2.0	51.4	4.0	0.8	0.6%	2	0
Ruths Berkshire, in pig	6,400,000	7,000	54.4	4.6	31.0	6.4	1.4	0.3%	4	0
2-year-old L. White, in pig	5,440,000	11,000	49.4	1.8	46.0	2.8	/	0.2%	0	0
1½-year-old Berks, Suckling pigs	7,328,000	11,000	29.4	4.8	62.6	3.2	/	0.4%	0	2
1½-year-old Berks ,, ...	5,376,000	18,000	29.2	3.2	63.6	4.4	/	0.1%	2	6
2-year-old Tamworth ,, ...	5,472,000	19,000	22.0	3.4	72.6	1.8	0.2	0.5%	4	0
1½-year-old Tamworth ,, ...	5,728,000	13,000	43.0	3.0	47.2	6.8	/	0.8%	2	4
1½-year-old Berks ,, ...	6,400,000	21,000	32.8	2.0	59.6	5.6	/	0.7%	6	4
2-year-old L. White ,, ...	5,600,000	9,000	44.2	4.6	46.2	4.4	0.6	0.1%	0	0
2-year-old Gloster ,, ...	5,580,000	10,000	38.8	4.6	53.2	2.4	0.1	0.8%	2	0
Average	7,380,000	15,000	38.8	3.7	52.9	4.1	0.4	0.4%	2	1
Limits ... ... {	5,376,000	9,000	22.0	1.8	31.0	1.8	/	0.1%	0	0
	9,046,000	28,000	54.4	7.6	72.6	5.4	1.4	0.8%	6	6

TABLE IX.
FINDINGS OF VARIOUS AITHORS FOR NORMAL PIGS.

	Red.	White.	Ly.	Mo.	Ne.	Eo.	Ba.		
Sucklings ...	3,630,000	11,000	35.0	3.2	61.8			Regner per Rudolf	(17)
Sucklings ...	2,390,000		57	2—5	36	1—8	1—2	Sepmtleben per Rudolf	(17)
Sucklings ...	2,850,000—7,800,000	8,200 —41,000	41.6	8.3	54	2.0	1.6	Gutig per Rudolf	(17)
2—6 months ...		29,000	34	1.75	58.2	2	4	Gutig per Burnett	(2)
4 months ...	6,000,000—7,420,000	15,000—28,000	53—65	0.6—4	25—40	1—7	0—3	Dietl per Rudolf	(17)
3—10 months ...	6,300,000—9,500,000	9,700—16,800	21—70	0.5—11	20—75	0—19.5	0—2	Magnus and Ibrahim Said	(13)
2 months—1 year	6,400,000—7,300,000	16,000	42—59	3	37—49	3	1—2	Regner per Rudolf	(17)
Adult	5,700,000—6,400,000	15,000						Doyle, Mathews and Whiting	(7)
Adult	6,030,000—7,284,000	15,900—28,700	23.9	2.7	72.9	0.4	0.1	Kohanawa	(11)

TABLE V.

THE EFFECTS OF PARTURITION ON THE BLOOD OF A SOW.

	Rbcs.	Wbcs.	Ly.	Mo.	Ne.	Eo.	Ba.	Retics.	N.	J.
Sow, 2 years old, five days before farrowing:	5,760,000	13,000	40.2	4.6	52.4	2.0	0.8	0.6%	1	0
Three days before farrowing:	5,472,000	17,000	44.2	5.8	44.6	4.4	0.8	0.4%	2	0
Eight hours after farrowing:	5,544,000	45,000	4.0	2.4	93.4	0.2	0	0.9%	4	0
Twenty-four hours after farrowing:	5,584,000	15,000	48.0	6.2	42.6	2.4	0.6	0.4%	0	0

TABLE VI.

THE EFFECT OF ANAEMIA ON THE WEIGHT OF PIGS.

LITTER 1. Weight in pounds at weekly intervals.

	Birth	One week	Two weeks	Three weeks	Four weeks	Five weeks	Six weeks
Pig 1	9½	14	17	18	23	28	34
Pig 2	9½	13	15	17	22	27	32
Pig 3	6	9	11	12	15	18	21
Pig 4	10	14½	17½	20	25	29	31
Pig 5	5	7½	9	10½	13	17	20
Pig 6	5	9	8½	11½	13	16	18
Pig 7	10	14½	17½	21½	26	31	36
Pig 8	7½	11½	13½	16	19	24	28
Pig 9	9	14½	16	17½	23	28	33

LITTER 2. Weight in pounds at weekly intervals.

	Birth	One week	Two weeks	Three weeks	Four weeks	Five weeks	Six weeks
Pig 1	9½	12	12½	16	21	27	35
Pig 2	12	16	17½	20	26	32	39
Pig 3	8½	9½	11	14½	19	24	28
Pig 4	11	16	15½	17	21	27	32
Pig 5	11	15	16	19	24	30	36
Pig 6	14	15½	17½	22	28	34	44
Pig 7	11	14	16	20	24	32	35
Pig 8	11	14	14½	17	23	29	35

TABLE VII.

THE BLOOD OF PIGS AFFECTED WITH ANAEMIA.

	Rbcs.	Wbcs.	Ly.	Mo.	Po.	Eo.	Retics.	N.	J.
(*a*) *Gilt*	6,218,000	22,000	40.8	6.4	42.2	10.6	0.1%	–	–
Litter 21 days old:									
1	4,780,000	74,000	35.6	6.6	19.4	38.4	34%	3	–
2	3,748,000	28,000	63.4	4.2	17.8	24.6	22%	4	2
3	4,464,000	39,000	29.8	3.4	55.6	11.2	16%	–	–
4	*1,696,000	7,000	25.2	5.8	42.2	26.8	3.5%	1	–
5	†2,560,000	28,000	56	8.2	17.4	18.4	19%	–	–

**Died same day.*
†Died next day.

(*b*) Litter 30 days old:									
1	6,144,000	60,000	23.8	6.2	34.4	35.6	14%	–	–
2	5,760,000	31,000	56.8	4	24.8	14.4	12%	1	2
3	6,336,000	30,000	70	5	15.4	9.6	8%	1	–
(*c*) Litter 60 days old:									
1	7,680,000	13,000	45.4	4	46.6	9	1.2%	–	1
2	7,744,000	10,000	60	6.2	20.6	13.2	5.1%	3	–
3	4,576,000	23,000	82.4	4.4	8.6	4.6	3%	–	–

TABLE VIII.

THE EFFECT OF STRONGLYE INFESTATION ON THE BLOOD OF PIGS.

Non-anæmic pigs, four months old.

							Retics.	N.
6,880,000	47,000	29.2	9.8	57	4	–	0.3%	%
7,712,000	22,000	52	4.8	39.2	2.6	1.4	1.3%	–
6,520,000	22,000	25.4	3	69.4	1.2	1	2%	–

c*

SOME OBSERVATIONS ON THE POISONOUS PROPERTIES OF BUTTERCUPS

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INTRODUCTION.

During the past few years increasing attention has been focussed on the question of plant poisoning and as a result outbreaks of illness and death in cattle, horses and sheep have been reported to the Institute, the cause of which was considered to be due to the ingestion of buttercups.

The natural order Ranunculacæ to which the buttercups belong, contains some of the most poisonous plants known in this country, such as the Hellebores, Delphinium and Aconitum. Buttercups, however, have not been considered to be of a very poisonous nature and it would appear that from the absence of measures to control their spread, farmers at any rate do not regard them as a common source of injury to their livestock. Nevertheless, it has been realised since ancient times that they possess an acrid juice which is capable of producing painful blisters when applied to the skin and that certain varieties are more irritant than others. No precise information regarding their toxicity is, however, available, largely owing to ignorance of their chemical composition. Furthermore, the evidence on which a diagnosis of buttercup poisoning has been made is in many cases very scanty and often open to doubt.

Review of the Literature on the Toxicity of Buttercups.

The earliest account of the effects of the ingestion of buttercups is by Krapf in 1766 [quoted by Roques (1821) and Orfila (1852)], who conducted some experiments on himself with Ranunculus sceleratus. After swallowing a single well-crushed flower he experienced great pain and convulsive movements of the stomach. Not content with this, he proceeded to swallow two drops of the expressed juice of the plant, and, in addition to the above symptoms, burning and convulsive pains throughout the length of the œsophagus were experienced. Still not satisfied, he chewed the thickest and most succulent leaves of the plant. Soon his mouth was filled with saliva, his tongue became inflamed, the mucous membrane of his mouth peeled off and he lost the sense of taste. The juice of this plant administered to a dog produced anxiety, vomition, convulsions and general uneasiness, followed quickly by death. Post-mortem examination revealed gastro-enteritis [Orfila (1852)].

Several accounts of the harmful action of R. acris are to be found in the veterinary and agricultural journals. Thus Carruthers (1899) suspected it of causing scouring in young lambs and horses pastured in a field where the plant was growing profusely.

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In the *Veterinarian* of 1874, Gerrard describes an outbreak of poisoning in horses which were observed to be coughing badly and showed symptoms of colic. They were smacking their lips from which a ropy mucus hung, had an anxious expression and kept pawing the ground. At short intervals, some were seized with a curious spasmodic action of the throat, as if they had difficulty in swallowing; this was sometimes followed by eructation and a fit of coughing with a discharge of watery fluid through the nostrils. The buccal mucous membranes were red and turgid and the lips swollen. Recovery was practically complete in two days. These animals had been fed on freshly cut meadow grass largely composed of R. acris and R. flammula, chopped up with oat straw, oats and beans.

Mulvey (1919) records the death of four heifers which he ascribes to the ingestion of R. acris. The animals showed symptoms of depression, abdominal pain and blindness. Post-mortem examination revealed an intense inflammation of the stomach and intestines. Chemical examination of the brain and stomach contents of one cow revealed the presence of 0.31 grains and 3.70 grains of aconitine respectively, so that it is unlikely that the death of this animal was due entirely to the consumption of R. acris, since this plant has been repeatedly examined for the presence of aconitine without success. (Alkaloids are nearly always present in post-mortem material in very small amounts and their isolation in a pure state, uncontaminated with ptomaines and other organic bases, is almost impossible. For this reason their identification, based on colour reactions with chemical reagents alone, must be treated with the greatest reserve, and it is only when the chemical and pharmacological properties of the substance are in agreement that it can be identified with any degree of certainty.)

Orfila (1852) carried out some experiments on dogs with the expressed juice of R. acris. In one experiment he introduced into a dog by stomach tube 150g. of the juice and then ligated the œsophagus. One hour later the animal tried to vomit and died in twelve hours, having shown insensibility and increasing weakness. On post-mortem examination bright red areas were observed in the mucous membrane of the stomach and a large amount of blood-stained fluid in the lungs, which also showed a few patches of livid dense tissue. In another experiment 8g. of an aqueous decoction of R. acris was applied to the inside of the thigh of a healthy dog at 8 a.m. During the day the animal showed progressive weakness and died about 10 p.m. The site of application of the decoction was swollen, infiltrated and very inflamed, the inflammation extending to the muscles of the lower part of the abdomen. The lungs were reddened and filled with blood; the digestive tract was normal.

In 1886 Stock attributed illness in two horses to the ingestion of R. flammula. The man in charge of the horses had fed them handfuls of the plant for the previous four or five days because, " it was hot in the mouth and he thought it would warm them up." One, a black cob, was seen *in extremis* and was dangerous

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to approach. It stood with its head nearly touching the ground, and threw itself about with great violence. The other victim was a bay mare, seven years old, in good condition. The animal was seen to lie down with great care; it was dull, pulse 90 and almost imperceptible, conjunctiva reddened, tongue coated, teeth firmly clenched, body surface and extremities cold, skin dry, abdomen tympanitic and tender, and an absence of all sounds on auscultation. Death took place a few hours later. A post-mortem examination was carried out and the following findings were recorded. The œsophagus was swollen throughout its entire length, the stomach was tense and contracted and contained a small quantity of dark coloured fluid; the wall was enormously thickened, due to the exudation of a yellow serous fluid between the coats. This thickening extended throughout the whole length of the intestine causing complete occlusion in many parts; the surface showed an appearance consistent with the effects of a powerful vesicant on the mucous membrane. Ecchymoses were observed on the peritonium.

Flower (1864) describes the death of three heifers which were grazing in a field containing bitter vetch, R. acris, R. bulbosus and a large amount of R. ficaria. Post-mortem examination revealed extensive inflammation of the rumen, omasum and intestines. This record is, however, complicated by the fact that the day before the accidents occurred the animals had strayed into a plantation where wild hyacinth, cuckoo pint and yew were growing. There was no evidence, however, that these plants had been consumed.

A four-year-old Welsh mountain pony had been turned out the previous evening in a paddock bare of grass but " yellow with buttercups " [Litt (1860)]. The next morning it was found that it had eaten freely of these buttercups and was suffering acute pain; its mouth and throat were much inflamed and tender and it showed symptoms of enteritis. After 24 hours, however, it had recovered, although for several days difficulty in swallowing was observed.

Steyn (1929) carried out some feeding experiments with R. pubescens (Thurb). In a sheep he observed, half an hour after dosing with 330g. of the fresh plant in the pre-flowering stage, restlessness, hoven, accelerated pulse, diuresis and frequent defecation. The animal evidently suffered severe pain as it was very restless and groaned frequently. Recovery was complete three days later.

Another sheep, dosed with 200g. of the fresh plant in the flowering stage, showed similar symptoms and in addition developed a profuse greenish diarrhœa. Three days later the animal was still suffering so it was killed and a post-mortem examination carried out. This showed acute catarrhal enteritis with numerous hæmorrhages in the mucosa.

Cornevin (1887) gives the symptoms and post-mortem findings in cases of poisoning by R. sceleratus as typical of those produced by all the species of

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Ranunculus. The first symptom observed is that of gastro-enteritis followed by an evil-smelling diarrhœa, vomition and falling milk yield. Nervous symptoms may then make their appearance with slowing of the pulse, laboured respiration, dilation of the pupils and blindness. If large amounts have been eaten convulsions may supervene and death occur in six to twelve hours. Post-mortem examination shows inflammation of the digestive tract and sometimes nephritis. Pott (1907) mentions in addition to the above symptoms hæmaturia in cattle and " reddish or bitter milk in lactating cows."

As the above is a fairly complete review of the English veterinary literature on poisoning in animals attributed to buttercups since about 1850, it is evident that ingestion of these plants is not often fatal to the animals concerned. This is probably due, partly to the comparative innocuousness of the poisonous principles, and partly to the extremely irritant properties of the species, which causes inflammation of the mouth and lips thus discouraging the animal from consuming a fatal amount of the plant.

In view of the uncertainty which surrounded the whole question of the toxicity of buttercups, it was considered advisable to make a chemical examination of these plants in an effort to isolate the substance or substances to which the symptoms produced on ingestion of the plants by animals could be attributed.

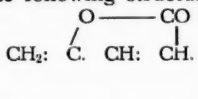
Chemical Literature.

It is only proposed to give a short summary of the chemical literature here.

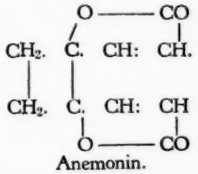
Heyer (quoted by Beckurts, 1892) observed that Anemone pulsatilla lost its irritant properties on steam distillation and that the distillate threw down colourless crystals on standing, to which he gave the name anemonin. From these results it was assumed that anemonin was the substance to which the irritant properties of A. pulsatilla were due.

In 1858 Erdmann subjected R. sceleratus to steam distillation and from the fresh distillate obtained an intensely acrid and lachrymatory yellow oil which on standing deposited crystals of anemonin.

Then in 1922 Asahina and Fujita published their comprehensive communication on anemonin isolated from R. japonica. The yellow oil, which on standing polymerised to anemonin, they called protoanemonin and assigned to these substances the following structural formulæ:



Protoanemonin.



Anemonin.

Kipping (1935) showed that protoanemonin could be titrated with NaOH at 60°C., and that the error was not greater than 2—4%.

Experimental.

It is evident from a survey of the literature that a yellow irritant oil is present in a large number of buttercups. As many of the species as could be obtained were examined and the white crystalline compound anemonin was isolated and identified from the following species: R. ficaria (lesser celandine), R. acris (upright meadow crowfoot), R. arvensis (corn crowfoot), R. flammula (lesser spearwort), R. bulbosus (bulbous crowfoot), R. sceleratus (celery-leaved crowfoot), R. sardus (hairy crowfoot), R. repens (creeping crowfoot), R. parvioflorus (small-flowered crowfoot), and R. lingua (greater spearwort).

Physiological experiments carried out by Nicholson (1933), however, showed that anemonin was devoid of all irritant properties, and attention was therefore directed upon the yellow irritant oil protoanemonin. As Kipping (1935) had shown that this substance could be titrated in aqueous-acetone solution with NaOH a method was devised whereby it could be estimated in reasonable quantities of the plant.

It is not proposed here to describe all the details of the method as it is hoped to publish this with further data elsewhere. Suffice it to say that it was found that steam distillation of the plant, extraction of the distillate with ether, removal of the ether and titration of the resultant yellow oil with NaOH gave satisfactory results. By use of this method it was, therefore, possible to estimate the amount of the acrid irritant oil in the plant with ease and accuracy.

(*a*) To determine whether at any stage of growth the amount of protoanemonin reaches a maximum.

R. bulbosus was chosen for this purpose as being one of the most suitable of the species, and accordingly a plot was laid down in the poisonous plant gardens of the Institute and the protoanemonin estimated at monthly intervals.

TABLE I.

VARIATION IN THE AMOUNT OF PROTOANEMONIN IN R. BULBOSUS THROUGHOUT THE GROWING SEASON.

Date.	Moisture per cent.	Per cent. Protoanemonin on fresh weight Basis.	Per cent. Protoanemonin on dry weight Basis.	Stage of Growth.
12/2/35	87.2	0.032	0.25	In rosette stages, old corms still attached to plant. Young tillers beginning to shoot.
13/3/35	84.7	0.065	0.43	Old corms disappeared. Shoots now 2—3in. high.
15/4/35	87.9	0.094	0.78	Some showing flower buds.
9/5/35	84.4	0.26	1.57	First flowers just out.
19/5/35	82.2	0.26	1.43	In full flower.
6/6/35	78.2	0.26	1.19	At period of fourth flower.
26/6/35	69.2	0.27	0.81	In full seed, not quite ripened off.
10/7/35	54.1	0.14	0.31	Leaves withered or dying. Per cent. Protoanemonin in corms.
3/10/35	Leaves 84.5 Corms 74.1	0.24 0.22	1.56 0.84	In Dormant Stage.

It will be seen from Table I that the amount of protoanemonin reaches a maximum when R. bulbosus is in flower, and in all probability this occurs in all varieties of buttercups. Accordingly as many species of buttercups were gathered as near their period of full flower as was possible and their content of protoanemonin determined. These results are set out in Table II.

TABLE II.

THE PROTOANEMONIN CONTENT OF VARIOUS SPECIES OF RANUNCULUS.

Date.	Species.	Per cent. Protoanemonin on fresh weight	Per cent. Protoanemonin on dry weight	Stage of Growth.
19/5/35	R. bulbosus	0.26	1.45	In full flower.
24/5/35	R. sardus. (var. Hirsutus)	0.56	3.15	In full flower.
27/5/35	R. acris	0.28	1.48	In full flower.
29/5/35	R. sceleratus	0.38	2.50	Just after full flower and beginning to seed.
3/6/35	R. repens	0.05	0.27	Just before full flower.
2/7/35	R. repens	0.04	0.19	At period of fourth flower.
6/6/35	R. parvioflorus	0.37	2.00	In seeded stage; few petals remaining.
28/6/35	R. arvensis	0.54	1.74	Period of fourth flower.
3/7/35	R. flammula	0.54	2.29	Period of second flower.
5/7/35	R. lingua	0.23	1.21	Period of third flower,

From this Table it will be seen that the amount of protoanemonin in the various species of buttercups varies within wide limits, and as all the varieties were grown in the Institute garden, the effect of different types of soil is eliminated.

(b) Examination of Buttercups for the presence of Alkaloids, Glycosides, etc.

R. sceleratus is commonly considered to be the most poisonous of the buttercups to livestock, but the presence of alkaloids, saponins or glycosides could not be demonstrated in extracts of the plant.

Mulvey (1919) in his paper on the poisoning of four cows by R. acris, records the isolation of aconitine from the brain and stomach contents in amounts of 0.31 and 3.70 grains respectively. It is also claimed that aconitine to the extent of 0.64 per cent. was isolated from the fresh plant, which is considerably in excess of that commonly present in the root of Monkshood (Aconitum Nepallus), Long (1924).

R. acris was, therefore, examined for alkaloids, but neither extraction with dilute HC1 nor ethyl alcohol acidified with tartaric acid yielded any substance which reacted with the usual alkaloidal reagents. If aconitine is ever present in R. acris it is unlikely that it ever occurs in any great amount, otherwise more fatalities would have resulted from its ingestion, for there is no doubt that R. acris is extensively grazed by stock, at any rate, in small amounts.

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(*c*) Examination of various species for the presence of cyanogenetic glycoside.

Greshoff (1909) and Jitschy (1906) both reported the presence of a cyanogenetic glycoside in buttercups, and the latter recorded the presence of 0.0087 per cent. HCN in R. repens. Various members of the species were, therefore, examined for the presence of HCN according to the following method.

A citrate buffer was used as recommended by Rimington (1932) made up as follows:

Solution A: 21.008g. citric acid+200c.c. N NaOH diluted to 1 litre.
Solution B: $\frac{N}{10}$ NaOH.

244 c.c. of Solution A+156 c.c. Solution B gives 400 c.c. of a Solution of pH 6.0.

About 100g. of the fresh plant was cut into small pieces and introduced into a flask containing 400 c.c. citrate buffer together with a little emulsin and tightly stoppered with a piece of picrate paper in the stopper. The flask was then placed in the incubator at 37°C. and if no reddening of the picrate paper was observed after 24 hours, the test was considered negative,

TABLE III.

THE OCCURRENCE OF A CYANOGENETIC GLYCOSIDE IN RANUNCULUS.

Date.	Species.	Stage of Growth.	Result.
25/3/36	R. sardus	In dormant stage	Negative
25/3/36	R. parvioflorus	In dormant stage	Negative
27/3/36	R. arvensis	About 6in. high	Positive
27/3/36	R. repens	Just started to grow	Negative
11/5/36	R. repens	Second flower	Negative
27/3/36	R. ficaria	In flower	Positive
27/3/36	R. bulbosus	Young tillers just beginning to shoot.	Negative.
11/5/36	R. bulbosus	First flower	Negative
28/3/36	R. auricomus	Just started to grow	Negative
30/3/36	R. acris	Just started to grow	Negative
11/5/36	R. acris	First flower	Negative

Consideration of Table III reveals the fact that only in R. arvensis and R. ficaria could the presence of a cyanogenetic glycoside be demonstrated, and in neither case was the test strongly positive. Jitschy (1906) had found 0.0087 per cent. HCN in R. repens, but no trace could be demonstrated in the sample examined at this Institute, neither in the first stage of growth nor in the flowering stage. Consequently it can be concluded that, although a cyanogenetic glycoside is present in some species of buttercups, at certain times of the year, this is the exception rather than the rule and little fear need be entertained of harm being caused to livestock from the decomposition of this glycoside with the liberation of HCN.

DISCUSSION

(*a*) Feeding Experiments, etc.

Feeding experiments have been carried out at this Institute by Nicholson (1933) with R. acris, R. repens, R. bulbosus and R. ficaria on rabbits, guinea pigs and sheep. In small laboratory animals no ill-health was caused by the

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feeding of these plants. Feeding of the juice to rabbits by stomach tube was then resorted to and, for this purpose, the juice of R. repens and R. acris was used. That from R. repens produced little effect, in one rabbit, apart from slight diarrhœa and loss of weight after 14 days. In all the animal received 991 c.c. of juice in 31 days without any marked effect, which might be expected from its low content of protoanemonin. The juice from R. acris, however, gave more definite results. In one experiment, after 40 c.c. had been administered over three days, the animal went off its food and showed progressive emaciation with thirst and diarrhœa. After seven days, muscular weakness was apparent and the animal was unable to stand without assistance. The juice was stopped after eleven days when the animal had received 208 c.c. Death supervened after the animal had been on experiment for fifteen days. Post-mortem examination revealed gastro-enteritis; the liver, kidneys, heart and lungs were normal on both macro and microscopic examination.

A three-year-old ram ate 47 lbs. of R. ficaria during eight days and a record of respiration, pulse and temperature was kept twice daily. The animal remained normal throughout the whole of this period and for the next three months.

It would thus appear from the above experiments that the buttercups which were used were not very poisonous, and that from the results obtained on administering the juice to rabbits, their harmful nature could be attributed wholly to their content of protoanemonin. A survey of the literature bears out this contention for very few fatal cases of buttercup poisoning have been recorded in the last half century considering the widespread incidence of the species.

Although a few species of Ranunculus contain a cyanogenetic glycoside which is capable of splitting off HCN under suitable conditions, poisoning of livestock from this cause is highly improbable under normal conditions, due to the extremely small quantities of this substance capable of being generated. This is clearly shown in Table III where eight species of Ranunculus were tested and only two were found to give a positive reaction for HCN.

(*b*) **Does Fatal Poisoning ever occur from the Ingestion of Ranunculus?**

A diagnosis of fatal plant poisoning should never be made unless the following conditions are fulfilled:

(*a*) The suspected plant was growing in the pasture or was accessible from it and had been eaten.
(*b*) The plant was found in the stomach contents.
(*c*) The symptoms, course of the illness and post-mortem findings were consistent with those found in authenticated cases of poisoning by the suspected plant.
(*d*) All other causes of death had been excluded.
(*e*) The poisonous principle of the suspected plant was isolated from the stomach contents and it had been absorbed as shown by its presence in blood, liver, kidney, etc.

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The last postulate cannot always be fulfilled because unless much more than the fatal dose of the plant has been ingested, the amount remaining unabsorbed after death may be so small that chemical identification, which is difficult at any time, may become impossible. Moreover, although a positive result is of great value, a negative result does not exclude the possibility of poisoning by the suspected plant.

The diagnosis of buttercup poisoning is extremely difficult because the post-mortem changes, which are to be expected from a knowledge of the properties of protoanemonin, are confined to intense inflammation of the digestive tract which, being a non-specific lesion, may be due to a variety of causes. Furthermore, the chemical isolation and identification of protoanemonin in post-mortem material is not possible because it will react with many compounds present in the stomach and intestines and so lose all its chemical characteristics.

Therefore the diagnosis of buttercup poisoning must rely on the following points: (1) The presence of buttercups in the ingesta; (2) The finding, on post-mortem examination, of an intense gastro-enteritis; and (3) The exclusion of all other causes of death. Consequently the diagnosis of fatal poisoning becomes almost impossible as buttercups will nearly always be found in the ingesta of animals grazing on a buttercup-infested pasture, and the presence of a gastro-enteritis is not of much aid in making a diagnosis.

It has been shown in Table II, using R. bulbosus, that the greatest concentration of protoanemonin occurs between the times of flowering and seeding, this period lasting in 1935 from the beginning of May till the end of June. As many animals are put out to pasture about the beginning of May, their powers of discrimination with regard to palatable plants are probably less than at any other time of the year, owing to the lack of experience and a voracious appetite for green food, and so it is possible that they may consume fairly large quantities of buttercups on heavily infested pastures. The rapidity of action of protoanemonin, however, and the exceedingly painful irritation to which it gives rise would, in all probability, deter the animal from feeding more than once on the plant. Unless a pasture is composed entirely of buttercups an animal would probably not consume more than 50 per cent. of its food as buttercups, which limits the horse and cow to about 5 lbs., and the sheep to about 2 lbs. of fresh buttercups at one feed. In the case of R. acris and R. bulbosus, two of the most widely distributed of the species, this would represent a consumption of between 5 and 6 grammes of protoanemonin by the horse or cow and about 2 grammes by the sheep, and it is improbable that this amount will cause the death of the animal. (In an experiment carried out by Nicholson (1933) on a rabbit the intravenous injection of 1 c.c. of the oil produced no effect other than a transitory rise in the blood pressure.) Consideration, however, should be given to the possibility that the damage caused by protoanemonin to the mucous

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membrane may result in an increased permability of the digestive tract and so facilitate the absorption of other poisons; this, however, is a problem which has yet to be investigated. There is no doubt that consumption of buttercups does cause illness and sometimes diarrhœa. Thus the normal physiological balance of the animal is bound to be upset and so result in a reduction of milk yields in cows and a checking of the growth rate of fattening lambs and bullocks. Fattening lambs and heavy milking cows, off condition for a week, may result in a considerable financial loss to the farmer concerned, consequently widespread eradication of buttercups from heavily infested pastures is very desirable. This can be carried out quite easily and effectively as has been shown by Stewart and Wright (1933), who found that spraying with a 3 per cent. solution of potassium chlorate, at the rate of 50 lbs. to the acre, controlled R. repens without any scorching of the grass.

Finally, it may be mentioned that the immediate application of a dilute solution of potassium permanganate protects the skin from the irritant action of protoanemonin, and that this is probably the most efficacious treatment for cases of suspected buttercup poisoning, although this will only help to destroy the remaining protoanemonin and will not alleviate the symptoms already produced by the oil.

Summary.

From the foregoing experiments it can be concluded that the acrid properties which have long been ascribed to buttercups, are due to the presence, in the fresh plant, of a yellow vesicant oil called protoanemonin which volatilises on drying. Thus the innocuous nature of dry buttercups when fed in hay, etc., can be explained.

A method has been evolved for the estimation of protoanemonin in these plants by titration with standard NaOH and the concentration of the oil has been determined, in the following species, as near the period of full flower of the plant as was possible: R. acris, R. lingua, R. parvioflorus, R. bulbosus, R. repens, R. arvensis, R. flammula, R. sceleratus, R. sardus.

The variation in the protoanemonin content of R. bulbosus was followed at monthly intervals throughout the growing season and it was observed that the protoanemonin reached its highest concentration during May and June, from the period when the first flower began to appear until the seed was just ripening off.

Repeated examination of various species for the presence of a cyanogenetic glycoside was carried out and only in two instances could the presence of HCN be demonstrated, viz., in R. arvensis and R. ficaria and then only in very small amounts.

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From a consideration of the concentration of protoanemonin in buttercups, and from the fact that the presence of no other harmful substance could be demonstrated, it had been concluded that the harmful properties of these plants can be attributed solely to their content of protoanemonin. Pharmacological experiments carried out with the oil have shown that large doses must be administered before death ensues. Consequently it must be emphasised that great care should be exercised in making a diagnosis of fatal poisoning due to the eating of buttercups. Although they frequently cause illness, it is doubtful whether they ever prove fatal because, under normal circumstances, before enough of the plants can be eaten, the blistering action of the oil on the buccal mucous membrane will have become so great that mastication will have become almost impossible.

Thanks are due to Mr. C. W. B. Wright, botanist to the Institute, who collected and grew all the plants used in this investigation; to Professor J. A. Nicholson, late of this Institute for permission to incorporate some of his results in this paper and also to Dr. H. McCombie and Dr. F. B. Kipping of the Chemistry Department in the University, for much helpful advice.

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Clinical Articles

A CASE OF INFECTION OF THE HORSE WITH ERYSIPELOTHRIX RHUSIOPATHIÆ (SWINE ERYSIPELAS)

By J. S. PATERSON, M.R.C.V.S., D.V.S.M.
Institute of Animal Pathology, Cambridge University
and
Major T. G. HEATLEY, O.B.E., M.R.C.V.S.,
Woodbridge

THE recovery of E. rhusiopathiæ (swine erysipelas bacillus) from animals other than the pig, has been frequently recorded though the occurrence of the organism in the horse is apparently somewhat rare. Pfeiler and Heinrich, quoted by Friedmann (1934) observed the association of the organism with outbreaks of arthritis in foals; Goerttler (1925) described the occurrence of serofibrinous arthritis in horses which had been injected with living cultures of the organism for the production of Swine erysipelas antiserum: Guillot and Pigoury (1933) isolated cultures of E. rhusiopathiæ from the bone marrow of a horse which had died from a paratyphoid infection, but they were of the opinion, that in this case, E. rhusiopathiæ was an agonal invader.

The following are the details of a case of apparent natural infection of the horse which came to our notice recently.

On 13th May, 1937, one of us (T.G.H.) was called to attend a three-year-old Suffolk filly running at grass with several unshod colts. She was found to be very lame in the left shoulder. Examination failed to show evidence of any injury. The lameness improved and the filly was again turned out to grass. On June 18th a further examination was made and the left hock was found in a markedly painful and swollen condition. The temperature was raised, the pulse rapid and the appetite capricious and on each subsequent examination the same general symptoms were observed. Swelling of the hind fetlocks developed later, the filly became gradually very stiff and eventually it was only with difficulty that she could rise from the ground. Local treatment did not effect any improvement. On August 21st the filly was destroyed.

The striking condition on post-mortem examination was a typical verrucose endocarditis of the mitral valves, each of which had extensive "cauliflower" vegetations on their ventricular surfaces.

Bacteriological Examination

(J.S.P.)

Smear preparations from the heart vegetations and from the synovial membrane of an affected joint were made and microscopic examination revealed

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numerous long, thin, weakly Gram-positive interlacing filaments forming small clumps. Serum agar plates were sown with dilutions of saline emulsions of the vegetations and the synovial membrane and colonies were picked off after 24 hours incubation at 37°C. Pigeons were inoculated with similar emulsions. Death occurred in from 5 to 6 days and from the heart blood pure cultures were obtained. A study of the organism isolated by both methods showed it to be a thin gram-positive rod about 0.4c. × 1.2c. On serum agar it produced minute smooth dew-drop like colonies in 24 hours. In serum broth a slight floccular sediment was found. The organism is non-motile, and does not form spores. It forms acid but no gas when grown in the following " sugars "; lactose, glucose, maltose, lævulose, soluble starch, dextrin and galactose. In arabinose and xylose only a trace of acid formation was observed. No alteration occurs in saccharose, mannitol, dulcitol, inositol, glycerol, inulin, salicin, raffinose, rhamnose or litmus milk. Methylene blue milk (1/5000) was almost completely reduced in 24 hours but the colour returned in 72 hours. A suspension of the culture was agglutinated by an E. rhusiopathiæ agglutinating serum to its known maximum titre. The organism is pathogenic for pigeons following intramuscular injection and scarification of the skin, and for mice by subcutaneous injection. Pigeons which received 3 c.c. of a potent swine erysipelas antiserum intraperitoneally, withstood 0.5 c.c. of a 15-hour broth culture injected intramuscularly, while the control, unprotected pigeons, died in 5 to 6 days. The addition of the same serum to cultures in vitro rendered them non-virulent when tested in pigeons.

Discussion

This would appear to be a case of natural infection with E. rhusiopathiæ. The organism isolated conforms to that found in outbreaks of swine erysipelas in this country as described by Edwards (1929) and Topley and Wilson (1936). It is of interest to note that although pigs have been bred on this particular farm for about 45 years, there has never been any suspicion that swine erysipelas existed amongst them at any time. The pigs are housed in buildings in close contact with the stables and horse yard.

Summary

(*a*) A case of E. rhusiopathiæ infection in the horse is recorded.

(*b*) The disease had many features in common with chronic swine erysipelas in pigs.

(*c*) The organism isolated is apparently identical with that found in pigs in this country.

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THE GRAVITATION TREATMENT OF TRAUMATIC PERICARDITIS IN CATTLE

By DAVID ERIC WILKINSON, M.R.C.V.S.

WHEN first I heard of Prof. Imries treatment of cattle affected by traumatic pericarditis, I was so struck by the practical simplicity of the method that I resolved to adopt it whenever opportunity offered. Imrie advises that the affected animal be placed upon an inclined plane so that the forehand is some twelve or eighteen inches higher than the hind quarters. The rumen and other abdominal contents then tend to gravitate backwards and so relieve pressure upon the diaphragm. It is presumed that this action may cause any foreign body embedded in the reticulum, and which might pierce the diaphragm and pericardium, also to recede.

The first opportunity arose on February 6th, 1930, when I was called in to examine a roan Shorthorn cow which her owner said had pneumonia. This animal had a temperature of 107F., was obviously in great pain, standing with elbows turned out and ribs arched, and moving with reluctance. She had spasms of pain accompanied by blowing respirations at intervals, but the hurried breathing was intermittent. When blowing hard her tongue was protruded and the respirations were accompanied by a short, painful grunt. Auscultation of the heart showed unmistakable symptoms of pericarditis, the heart sounds being blurred and the tinkling of pericardial dropsy being easily noted. A diagnosis of traumatic pericarditis was made. The owner then informed me he had lost two other cows from the same cause and on enquiry I found his grass land was annually manured by stable manure brought from his stables in London and as these stables adjoined his packing warehouse, nails and wire were often swept up in the stable manure. He was at first inclined to slaughter the animal, but as I pointed out, she would only be fit for the knacker, as she was running a high temperature, he consented to an attempt to reduce the fever and fatten her for the butcher, realising at the same time the danger of a fatal termination to her illness. The animal was tied up by an ordinary cow-chain upon an inclined plane formed by half-a-dozen wide planks set up on the front edge of her manger and sloping down to the floor behind. These planks were supported by several barrowloads of earth and the cow left in this position which seemed to give her a certain amount of relief almost immediately. Some febrifuges were given in her food and water and next day a laxative was administered. The animal's temperature fell steadily day by day until in a week it was normal. Her appetite returned and she began to put on flesh. About six weeks later, at the end of April, she was sold to the family butcher and made a fair carcase of beef. The butcher reported finding a piece of wire embedded in the reticulum. In the casual manner of many of one's clients with regard to one's interesting cases, I was not informed until too late to see the carcase, of the owner's decision to send the animal to the butcher!

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The next case to which I was able to apply this line of treatment arose on March 10th, 1936, the subject being a very good, pedigree Red Poll cow which had calved a week before. The symptoms were similar to the case just cited with the addition that this cow was frequently bathed in cold perspiration. (Incidentally I have never been able to understand why the physiologists teach us that cows do not sweat !)

Similar treatment was adopted with complete success. This cow was a very heavy milker and as the pain abated, her milk yield increased until she was giving more milk than during her previous lactation. She was kept " on the boards " for several weeks until the early Summer. Then as the other cows were always out at grass and she appeared to have tired of indoor feeding and began to fall off in milk, she was cautiously allowed out to graze. She showed no further symptoms of cardiac trouble, has had another good calf and is still milking well and apparently in the best of health.

My most recent case occurred in a very good Dairy Shorthorn cow on September 30th, 1937. Her symptoms were very acute and I feared a fatal termination. However, she very quickly responded to this line of treatment and is still " on the boards." When last I saw her on November 12th, she was giving 4½ gallons of milk daily.

THE EFFECT OF AN OVERDOSE OF SANTONIN ON YOUNG PIGS

By J. W. HALL MASHETER, M.R.C.V.S.

SIX-AND-A-HALF-POUNDS of Santonin were given to 70 nine-weeks-old pigs, at 7.30 a.m. It was administered in mistake for M_gSO_4. It was estimated that each pig would receive roughly 1½ ounces. The pigs were in batches of 10. The idea was to give each batch 15 ounces, i.e., 1½ ounces to each pig. The probability is, that the santonin was unevenly mixed and some pigs got much more than the others, because only 10 of them showed severe symptoms. These 10 were not all in the same pen which bears out the above supposition. On the other hand it may be that the santonin showed a predilection for these pigs, or inversely the pigs showed a predilection for the santonin. The latter is not very probable. All the feed was cleared up.

Symptoms.

The symptoms varied from nothing appreciable in some, standing with the back arched, tail limp, ears depressed and looking very miserable, in others—to epileptiform convulsions, clonic spasms and cessation of respiration for an appreciable while, shivering, jaws moving as if grazing, or biting any object they came up against, in the badly affected.

The urine was deep yellow in colour, watery at first and clear, but becoming very much thicker and opaque later.

Treatment.

Two ounces of linseed oil given to each pig as a drench, followed by 1 pint of milk, i.e., 10 pints to the pen, in the trough instead of their usual feed. The milk was given three times a day for two days.

By evening the oil was working satisfactorily.

Result.

There were no deaths and in three days all were normal again, and were feeding well. As an anthelmentic the dose taken was certainly efficacious, if somewhat expensive. It cost about £42.

Discussion.

It would thus appear that santonin is a safe vermifuge for young pigs as it gives such an enormous margin to toxicity. The normal dose for this sized pig being 5–8 grains, yet, 1½ ounces, or probably much more in some cases, was

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taken without causing a single death. It would also appear from this experience that the literature requires revision as the account in Hoare's "Veterinary Medicine and Therapeutics," 1933, is contradictory (*vide* "Action and Uses," p. 307).

(1) "It is fairly *rapidly absorbed* from the small bowel in the form of santonate."

(2) "Being *very insoluble* the major portion is *not absorbed*."

This appears to me to be somewhat contradictory. Again:

"Santonin may be administered with a mild saline."

This also appears to be wrong, because an alkali converts santonin into a santonate, which "is fairly rapidly absorbed from the bowel," and, presumably sets up the syndrome seen in the worst of these cases. We do not want "rapid absorption," but rather do we want *non* absorption from the bowel and action on the parasites *in* the bowel.

Santonin followed by an oliaginous purge seems to be a more rational procedure.

AN ANTI-SLIPPING SHOE FOR THE HORSE

By J. McCUNN
Royal Veterinary College.

MODERN roads are not built for horse traffic. The diminution in the number of working horses, especially trotting horses, in our towns is in no small measure due to the fear of the roads which has become so prevalent of late years. No sensible person would care to return to the mud and filth of the roads of the past. Given a good and sure foothold for the horse the modern road is an advantage. Less energy is required to move a load and therefore an animal can pull much heavier loads. This is a distinct commercial asset in favour of horse-drawn traffic. It would appear that in spite of experiments a non-slip road is still a long way off. It behoves us, therefore, to investigate the question of non-slipping shoes. Many and various are the inventions which have this end in view. It has recently been my privilege to collaborate with Mr. Hitchin, the foreman of the Royal Veterinary College, in an attempt to produce a non-slip shoe. The device which I describe is entirely Mr. Hitchin's invention; my own part has been small, namely trial and investigation.

It is a well-known fact that slipping can be almost avoided if two surfaces made of different materials are brought into contact with the ground at the same time. The rubber heel of a boot into which there is inset a centre of leather is probably the best example of this.

The Hitchin anti-slip device takes advantage of this principle.

The shoe is prepared with a shoulder at the heel. Specially shaped rubber pads are now riveted to this shouldered portion.

The ground surface of the shoe is then completed, the toe and fore-parts of the branch being of iron and the heel portion rubber (*illustration*). Ordinary horse shoe nails are used as the rivets. The lateral movement of the pad is checked or controlled by an internal flange.

I have been able to give these shoes a considerable trial and this trial has given me the greatest satisfaction.

It has been found that:

1. The rubber will wear longer than the iron.
2. The life of the shoes, even in severe wearers, is considerably lengthened. In one stud of 8 horses, the cost of shoeing has been reduced by one-half since the introduction of this method of shoeing.

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3. There is a great diminution in concussion effects.

4. Slipping is eliminated.

5. The physiological action of and the hygiene of the hoof is not interfered with.

I have been able to give these shoes extensive trial on a number of riding and commercial horses. In the case of the riding horses, the shoes are safe to use on grass.

The only difficulty that I have encountered is that of the farrier. I have found that some of them are very diffident about using anything new or anything which necessitates extra labour, such as shouldering the shoe. Under gentle persuasion, however, several of these men have become great supporters of the pads.

I publish this note in the hope that others may put these pads to the trial. It is very gratifying to me to see such an excellent device is the product of the fertile brain of one of the members of the lay staff at the R.V.C.

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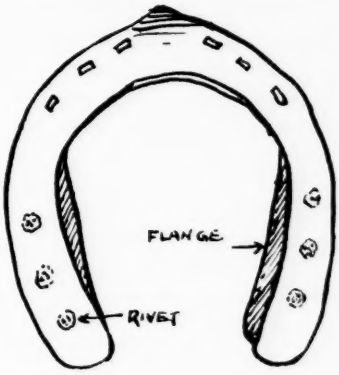

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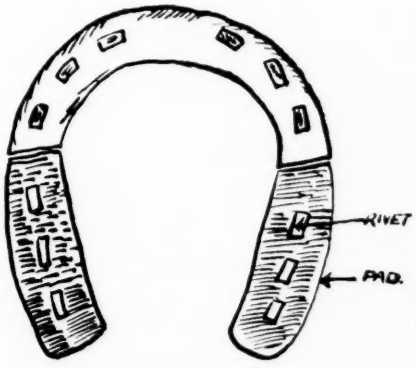

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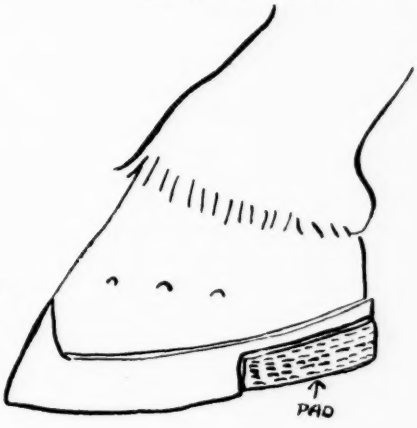

LATERAL VIEW

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Abstracts

OBSERVATIONS ON "DRY COAT" IN HORSES

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Published in Annual Report of Veterinary Department, Straits Settlements and Federated Malay States, for the year 1936.

Equine Anhidrosis or Dry Coat.

RECENT research in India having suggested that dry coat in race horses was a form of sub-acute heat stroke and a disease of dietetic origin associated with avitaminosis C, lack of sodium chloride, and hypofunction of the adrenal cortex, it was decided to try the effect of incorporating in the diet such materials as would ensure that adequate amounts of sodium chloride and Vitamin C were supplied, and to feed whole gland adrenal powder to compensate for any adrenal hypofunction.

One partially dry coated animal and one completely dry coated animal were fed on the lines indicated, Vitamin C being provided by feeding two pounds of germinated gram daily, and sodium chloride by the addition of four ounces of common salt to the food or drinking water. In order to compensate for any adrenal hypofunction, whole gland adrenal powder was fed in doses varying from 15 grains to 120 grains daily. The amount of Vitamin C fed was later increased by the addition of six pounds of "katchang hijau" sprouts to the food, and to combat the anæmia from which both animals were suffering an iron, copper, and strychnine mixture was administered.

During the course of treatment various subsidiary lines of treatment were tried including the feeding of orange juice to supply additional Vitamin C, glucose in an endeavour to provide a readily available supply of energy-producing blood sugar, potassium and sodium bicarbonates to compensate for any tendency to acidosis, potassium iodide to supply iodine for the thyroid gland, adrenalin to compensate for any deficiency in the secretion of the adrenal medulla and, finally, yeast to provide Vitamins B_1 B_2 B_3 B_4, an insufficiency of certain of these vitamins being responsible for the occurrence of certain skin affections having some resemblance to the skin lesions encountered in dry coated animals.

The net result of treatment in the case of the partially dry animal was a marked improvement in the general condition including the coat, and increased perspiration after exercise. After two months' treatment the animal could not be described as a free sweater, although it certainly sweated much better than it did at the commencement of treatment. (Identical results have been obtained in Kuala Lumpur (Selangor) in three partially "dry coated" horses similarly

treated. In these cases the treatment was limited to the administration of germinated gram, powdered adrenal cortex, and sodium chloride. Little if any improvement was noted in a fourth animal showing more severe " dry coat " symptoms, but otherwise in excellent condition.)

In the case of the totally dry animal—a light coloured chestnut under treatment for three months—there was a similar improvement in general condition and the coat assumed a distinctly darker hue, the skin lesions about the face having also practically disappeared. There was a decided improvement in the concomitant anæmia from which this animal was suffering, the blood colour index rising from 0.41 in the middle of treatment to 0.68 at the end of the third month. In spite of the general improvement in health the animal remained practically completely dry coated, although it did improve to the extent of sweating a little on the face and neck after exercise.

In a general review of the treatment of the totally dry coated animal the following observations are made:

(i) Administration of adrenalin in 4 c.c. doses subcutaneously regularly produced sweating within 5–10 minutes and lasting for about 30 minutes. The hair on the areas where the adrenalin had been injected subsequently became lighter in colour and the skin of the areas concerned seemed to be drier than the surrounding skin so far as any evidence of sweating was concerned. After a lapse of about five weeks the hair on these areas assumed a distinct sheen and became darker than the surrounding hair. The skin of these areas then also appeared to perspire freely and normally. The cause of this phenomenon, which was so strikingly obvious, is not understood.

(ii) Feeding of katchang hijau sprouts (obtained by germination of locally grown green peas and containing Vitamins A, B_1 and C) $3\frac{1}{2}$ to 6 pounds daily, caused a marked improvement in the skin lesions associated with dry coat but did not bring about any obvious improvement in sweating.

(iii) One hundred and twenty grains whole adrenal gland powder administered daily did not produce any increase in sweating and it is doubtful if it had any effect in producing the improvement of the coat which was noted under " Taugai " feeding.

(iv) Administration of Glucose D in one pound doses daily did not seem to produce any marked result.

(v) The effects of the administration of yeast (containing Vitamins B_1 B_2 B_3 B_4) were difficult to judge as it was only given during the last four days of treatment, but the coat seemed to improve appreciably under yeast treatment and there was a suspicion of a general sheen developing over the whole coat on the evening when the animal was sent back to its owner.

(vi) After three months' treatment a red cell count of 9,000,000 with a hæmoglobin percentage of 88 giving a colour index of 0.68 showed that a marked improvement in the anæmia had resulted in addition to an improvement in the coat. The feeding of iron is not considered responsible for the improvement

as the colour index after 18 days of iron feeding was only 0.41, the red cell count being 12,350,000 and the hæmoglobin percentage 72, nor are the large doses of sodium chloride considered responsible for the improvement. The factors remaining for consideration are (1) whole gland adrenal powder (120 grains daily), (2) potassium iodide (supplying iodine to the thyroid gland), (3) " Taugai " (supplying Vitamins A, B_1 and C) and (4) yeast (supplying Vitamins B_1 B_2 B_3 B_4). Which of these four factors was mainly responsible for the improvement cannot be decided on the available evidence but it is noteworthy that human tropical anæmia is now said to be successfully treated with marmite (yeast extract), containing Vitamins B_1 B_2 B_3 B_4 and that there was a visible improvement in the animal's coat after four days' yeast feeding.

(vii) Although the average temperatures and the relative humidity in Taiping (Perak) are no higher than those obtaining during the wet season in those districts in India where complete cures are said to have been effected by Vitamin C, sodium chloride and iron treatment, the results obtained locally by this method of treatment, were disappointing, although there is no doubt that treatment on the lines indicated resulted in a decided improvement in general condition. It is extremely doubtful however that this general improvement can in any way be attributed to the Vitamin C content of germinated gram or katchang hijau sprouts since it is generally believed that all animals except man, monkeys and guinea pigs can synthesise their own requirements of Vitamin C by the action of bacteria in the gut; special provision of this vitamin in the diet of horses should therefore be unnecessary.

(viii) The climatic factors which contribute to the production of dry coat are said to be a combination of heat and humidity, and it is known that in Malaya animals can be cured, temporarily at any rate, by sending them to high altitudes like Ringlet (3,600 feet) on the Cameron Highlands, where the mean temperature is about 67° F. and the relative humidity slightly higher than on the plains. This raises the question as to whether improvement could be affected on the plains by the use of air-conditioned stables in which both temperature and humidity could be controlled, or by keeping horses in stables kept cool by the use of a refrigerating plant or other cooling device. From these observations one immediately practical point which arises is that, under present conditions of stabling in Malaya, cool well-ventilated stables are advisable.

SOME COMPLICATIONS FOLLOWING EPIDURAL ANÆSTHESIA IN CATTLE

W. Hofmann, of the University of Bern, who is attached to the Veterinary Ambulatory Clinic (writing in " Schweizer Archiv für Tierheilkunde," for October, 1937), gives an account of some complications following epidural anæsthesia. During a ten year period of its use in several hundred cases only nine mishaps have occurred:

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The dose used is important, 10 c.c. of a 0.5—1 per cent. solution of autoxicocain, tutocain or similar solution is sufficient for anæsthesia of the vulva, vagina or uterus. For wider areas the dose is correspondingly increased. With 60—120 c.c. the whole hindquarters are anæsthetised. The animal goes down and these relatively large doses are well borne.

1. In three cows after an anæsthetic injection of 10 c.c., paralysis of the tail followed and it could not be used against insects or lifted when dunging. After several months the paralysis declined, but never completely disappeared. In my opinion the cause was due to an infection of the spinal canal—a mere trauma could hardly be the cause.

2. In three animals two or three weeks after injection abscesses formed at the site of puncture. In one stud bull the tail was carried strongly to the left. In an aged cow, after abscess formation, paralysis of the tail occurred and continued. In two animals after opening of the abscesses recovery followed.

3. In the above stud animal after a few weeks we were called upon to perform myotomy on the anus-penis muscles. 100 c.c. of 1 per cent. solution of tutocain was used. It was difficult to inject and had no effect. Probably growths were formed in the spinal canal as a result of the earlier purulent process. We have no knowledge whether such cases often occur since anæsthesia is seldom performed twice on the same animal.

Absolute surgical cleanliness and disinfection of the site of puncture and pure solutions are essentials in spinal anæsthesia.

4. It sometimes happens that with a minimal dose of 10 c.c. of solution an animal may fall down, with 15—20 c.c. it often occurs. Care should be taken that good bedding is put under the cow, and the head fastening suitable and safe. In one of our cows we had a broken horn and in another the cow got her head fast between the bars in front and only by quick removal of the bars was she saved from strangulation. In some cases it is wise to let an animal down with improvised slings.

5. One interesting case occurred in a bull which was operated on on account of impotence and in the region of sigmoid flexure both anus-penis muscles were severed. The operation was performed in a meadow and 80 c.c. of a 1 per cent. solution of tutocain was injected and the bull went down with its head much lower than its hind end. Immediately alarming symptoms occurred, laboured breathing, rolling of the eyes and opening of the mouth. It looked as if death would occur. The bull was quickly turned with its head uphill. After five minutes the startling symptoms disappeared. In this case the solution had run cranialwards and affected the nerves of the head, etc. Death would have followed in a short time if the position had not been quickly corrected.

In using large quantities of anæsthetic a flow of the solution towards the head must be avoided.

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HEALTH AND WINTER SPORTS HOLIDAYS

For reasons of health and pleasure, many medical men are recommending brief Winter Sports Holidays in Switzerland.

Such advice has been made possible, for those living in all European countries, by a well-organised co-operative effort of hundreds of hotels and transport agencies to put Winter Sports Holidays on a new and practical basis.

The English section of this enterprising Swiss hotel plan is headed by Mr. Douglas Bailey, late of Harrow and Cambridge; and £9 will cover an all-in nine days' holiday.

This modest sum includes fares, baggage, meals en route, all hotel expenses, tips, ski-ing lessons, unlimited trips on mountain and aerial railways, personal and baggage insurance, afternoon tea and daily baths. By cutting out the last two items the cost can be reduced to just over £7.

It means: six whole days amid glistening snows under sunny skies; and a happy change from Winter pallor to a glowing tan, the sun's therapeutic rays being aided by refraction from the snow. Such a holiday comes at a time when body resistance is at its lowest ebb, sending a man or woman back to work refreshed in mind and full of physical vigour.

At Davos—where the ice hockey and ski-ing championships are being held—although the average Winter temperature is only 21 degrees F., the average sunshine is five-and-a-half hours per day. Moreover the sun is so hot that the visitor can sit in the open without an overcoat. The air is very dry, and its clarity offers no barrier to the penetration of the ultra violet rays of the sunshine. Under such healthful conditions there is an intensity of exhilaration for those who ski, skate, toboggan or—walk.

Reviews

The Onderstepoort Journal of Veterinary Science and Animal Industry. Vol. 8, Nos. 1 and 2. January and April, 1937. Printed in the Union of South Africa by the Government Printer. Pretoria, 1937.

The two volumes comprise a book of 506 pages.

It is divided into nine sections or chapters. The sections deal with: (1) Protozoal Diseases; (2) Virus Diseases; (3) Parasitology; (4) Bacteriology; (5) Mineral Metabolism and Nutrition; (6) Sex Physiology; (7) Surgery; (8) Chemical Blood Studies; (9) Miscellaneous.

The book gives evidence of the good work being done in South Africa. It is printed on art paper and contains many excellent charts and it is well illustrated.

A list of the professional staff at Onderstepoort is included as is also an author's index.

The Journal is published quarterly, price 5/–, with overseas postage, 1/– extra.

Veterinary Diary and Therapeutic Index. 1938. Published by Bayer Products, Ltd., Africa House, Kingsway, London, W.C.2.

This excellent diary is again to hand. Handsomely bound, it contains much information of use to the veterinarian.

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The Chemist and Druggist Diary and Year Book, 1938. (70th year). THE CHEMIST AND DRUGGIST, 28, Essex Street, Strand, London, W.C.2.

THIS well-produced and very complete book is out again for the seventieth time. The literary contents are exhaustive, covering as they do everything from Air Raid Precautions to Stamp Duties. Veterinary Surgeons will find the Trade Directory and The Buyers' Guide useful, as they contain comprehensive lists of firms supplying drugs and of the drugs themselves. The diary is also very useful.

Handbook of the Diseases of Animal Acts and Orders of The Minister of Agriculture and Fisheries. 3rd September, 1937. Printed and Published by His Majesty's Stationery Office. Price 7*s.* 6*d.*

THE handbook brings up to date the various acts and orders and amendments there on. A perusal of its pages is instructive and at the same time awe-inspiring. That all these Acts and orders are necessary goes without saying, but it is doubtful if a prospective owner of any animal would complete the negotiations for the acquirement of the same if he was confronted with this handbook before the final stages of the process had been completed.

For this and many other good reasons we would strongly recommend the purchase of the handbook to all Veterinary Surgeons.

The Eleventh Annual Report of The University of London Animal Welfare Society.

THE Eleventh Annual Report of the University of London Animal Welfare Society has just been published. A perusal of its pages will demonstrate to the reader the wide sphere of the Society's activities and interests. It must be gratifying to those who helped in its inception, eleven years ago, to observe the enormous advance that has been made from such a humble beginning.

In the beginning there were many sceptics who thought that scientific men and women were not interested in the welfare of animals. The work of U.L.A.W.S. has shown a constant expansion and one can only interpret this as showing that its officers and members are wholeheartedly behind the cause they expound.

Ten Colleges in the University have branches, it has corresponding members in most parts of the world and it makes contact in order to further their common interests with many animal welfare societies.

It would appear that to advance the objects and aims of the Society the methods followed are largely of an educational nature. The ever-increasing growth of the Society would suggest that "To teach is better than to force."

Lectures, lantern and film demonstrations have been given by members and others at Schools, Colleges, Institutes, etc., in various parts of the country. The range of subjects discussed must be unique.

U.L.A.W.S. is now a body whose views and opinions carry weight and claim respect. There appears to be an absence of the "crank" spirit and an abundance of reason.

The noteworthy feature of the year's work is the campaign against the gin trap. The Society claims "That the progress that has been made towards the solution of the difficult problem of trapping" is a justification of the scientific approach to the problem of animal welfare."

It is pleasing to note that the Society's financial statement is a happy one, i.e., income has exceeded expenditure, and that with true business caution a small reserve has been built up which will allow of the continuation of activities should any crisis occur.

May we suggest that the time is opportune for an extension to other universities and although London may always claim pride of place, the title of the Society at some future date might become The British Universities' Animal Welfare Society.

The Physiology of Domestic Animals. By H. H. DUKES, D.V.M., M.S. 4th Revised Edition, pp. 695. Baillière, Tindall & Cox. 1937. Price 30s. 0d. net.

That a further revised edition of this work has been required so soon after its previous publication in 1935, is sufficient proof of its popularity, and importance in scientific literature. It has been enlarged by about 50 pages, although the number of chapters remains the same, i.e. 40.

To those familiar with this textbook on animal physiology it will be remembered that it comprises some eleven parts dealing with all the main aspects of its subject, but that on Reproduction originally written by Dr. McNutt has now been revised by S. A. Asdell, Professor of Animal Physiology in the New York State College of Agriculture. The first chapter in the book on the Physico-chemical basis of Physiological Phenomena is again undertaken by Dr. E. A. Hewitt.

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The author is to be heartily congratulated on the thoroughness of his task, which in part may be judged by the extent of the bibliography to be found at the end of each Part, for in all there are over 1,000 selected references.

As Professor of Veterinary Physiology, New York State Veterinary College, Cornell University, the author is obviously well acquainted with the high importance of his subject to practitioners and others investigating the diseases of animals, and therefore the reviewer feels that the book will make a wider appeal if it is possible for Dr. Dukes to stress, in the next edition, the material most capable of direct application to clinical veterinary practice.

The diagrams, charts and photographs add considerably to the value of the text, which is accurate, clear and of good style, though no doubt there are many who would disagree with the statement that " In practical nutrition, apparently the only minerals that are ever deficient are common salt, calcium, phosphorus, iodine, iron and copper."

Since there is no similar book available on avian physiology, it is refreshing to find numerous references to this subject throughout the text, but one hopes the author will incorporate more facts dealing with the functions of the organs of poultry (especially relative to digestion) in the near future.

Good books on physiology are scarce, therefore, it follows this must be one to be recommended to veterinary students, but although well written and full of experimental data and facts it is not one which students " cramming " for an examination will find easy reading. Also, there is probably not sufficient clinical or applied matter to appeal to the average practitioner. Nevertheless, for anyone wishing to study the functions of the animal body, veterinary surgeons desirous of keeping their knowledge up to date and to all physiologists this book is to be highly commended.

The publishers are to be again complimented on their important share in the publication of this new edition attractively bound and well printed.

Department of Agriculture, Canada.

Report of the Veterinary Director-General.

(George Hilton, V.S., H.A.R.C.V.S., D.V.M.)

For the year ending March 31st, 1937—Ottawa, 1937, J. O. Patenaude, Printer to the Kings Most Excellent Majesty.

In his opening remarks addressed to the Honourable the Minister of Agriculture, Mr. Hilton comments on the great freedom of Canada from animal plagues and the great care taken on the strict enforcement of appropriate protective measures. He states that the services of Lt.-Col. T. Dunlop Young, O.B.E., D.V.S.M., M.R.C.V.S., the representative of the branch in London, have been of much value in investigating local conditions in regard to contemplated importations and in furnishing advice to exporters concerning the department's requirements.

The demand for the control of bovine tuberculosis has been so great in recent years that it has been impossible to satisfy it. With approximately 3 million cattle under the department's control policies retest work has reached large proportions. Accredited areas are now formed in which the percentage of cattle infected with tuberculosis does not exceed one half of 1 per cent. for 3 years and for a period of 6 years of the infection did not exceed two-tenths of one per cent.

There is an optional Bang's disease-control policy and the number of herds under it is increasing and the importance is stressed that in addition to blood testing, strict sanitary procedure, the use of isolated maternity stalls and if additions must be made, selecting them from known negative herds. The regulations governing the importation of cattle now prohibit the discharge of cattle from Canadian seaboard quarantines until they have been blood tested for Bang's disease. Cattle reacting are slaughtered under inspection forthwith *without compensation* or returned to the country of origin. Cattle reacting are marked with a B tattoed on the right ear.

The Order governing the importation rule and use of veterinary biological products has been enforced as far as practicable. The Contagious Diseases Division, under A. E. Cameron, M.C., V.D., V.S., has had very little trouble with anthrax, glanders, hog cholera, and mange and dourine, sheep-scab and rabies have been non-existent. The great work has been with tuberculosis.

Accredited herd plan. Before an accredited herd certificate is issued the herd must include ten pure-bred registered cattle. An accredited herd is one which has passed 2 clean tests with an interval of one year or in case reactors were found in the herd 3 clean tests with intervals of 6 months. On March 31st, 1937, fully accredited herds numbered 7,827. Compensation for 2,602 reactors amounted to 118,234,66 dollars.

Owners of grade cattle who cannot qualify for the accredited herd plan may take advantage of the *supervised herd plan* to establish herds free from tuberculosis. No compensation is paid for reactors although they must be slaughtered under supervision.

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Restricted areas for the eradication of Bovine Tuberculosis. In restricted areas all cattle are tested with tuberculin the reactors slaughtered under supervision and compensation paid.

There are very many restricted areas in Canada now, but the matter there seems a far easier task than it will be in the United Kingdom. The initial percentage of reactors in many cases being less than 1 per cent. and in only 2 municipalites of Manitoba does it reach 25 and 24 per cent. There seems to be no difficulty in filling the places of reactors by sound cattle.

There is strict control of the garbage feeding of swine and periodical inspection of the premises. This measure perhaps accounts for only 2 outbreaks of swine fever during the year.

Cattle for breeding and milk production exported to Great Britain are tuberculin and Bang tested and tagged in the right ear with the letter C. The Meat and Canned Foods Division was under the control of Robert Barnes, V.S., and edible gelatine used in meats must be accompanied by a certificate that it meets the requirements of the Canadian Food and Drugs' Act.

Mr. E. A. Watson, V.S., is the Chief Animal Pathologist and superintends the manufacture of all biological products and the carrying out of examination of specimens for diagnosis. His work is big and very valuable.

A Poultry pathological laboratory is under the charge of C. H. Weaver, B.V.Sc.

This Report is interesting and comprehensive and as usual well worth perusal as a pointer to the effective control of animal diseases in the great dominion of Canada.

Publishers' Notices

All communications should be addressed to 7 and 8, Henrietta Street, Covent Garden, London, W.C.2. Telephone: Temple Bar 8568. Telegrams: "Bailliére Phone, London."

Letters for the JOURNAL, literary contributions, reports, notices, books for review, exchanges, new instruments or materials, and all matter for publication (except advertisements) should be addressed to the Editor.

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